METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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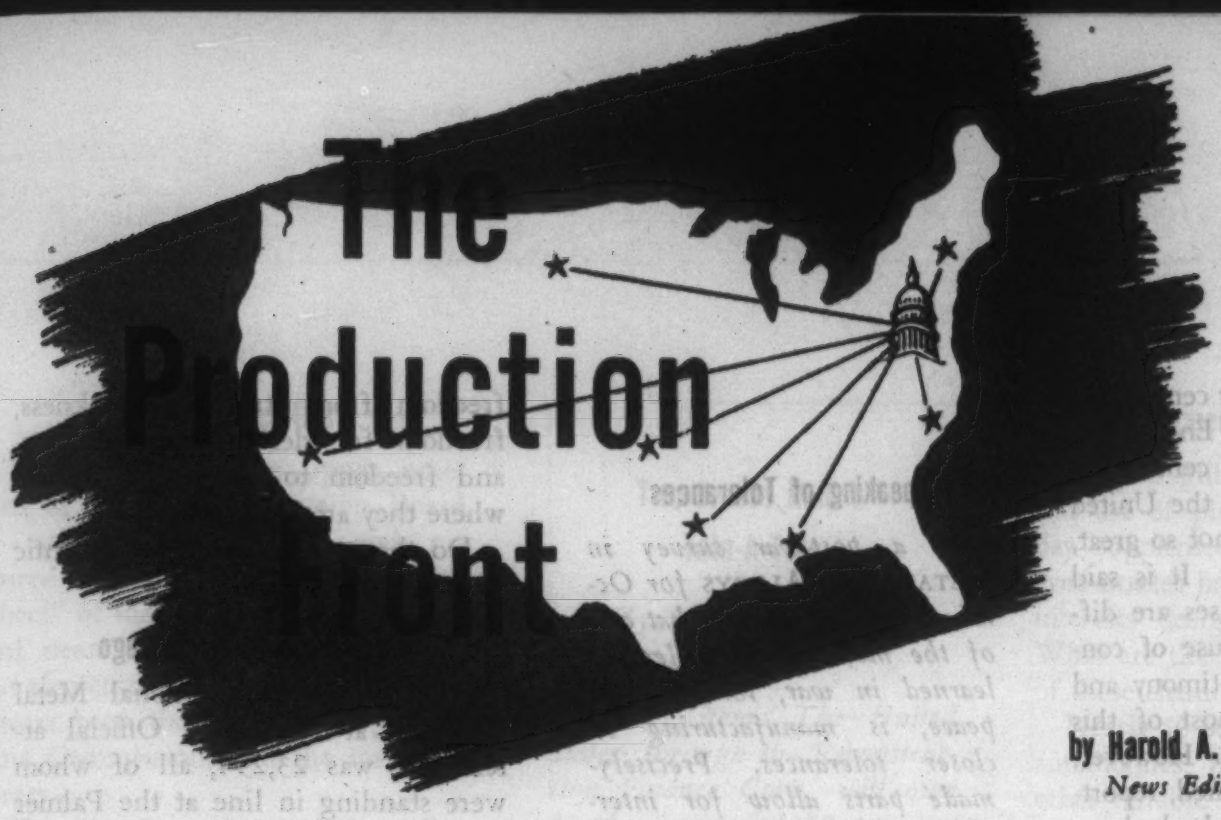


Extreme scarcities counted on a mutilated hand. . . . Steel shell makers return to brass. . . . Not so much interest in undiscovered mines or bonuses. . . . A great aluminum surplus. . . . Our "political metallurgists" rush forward with ideas. . . . Your 1944 pennies will have shot at Germans or Japs.

Brass shell cases contaminated by primer's lead. . . . Survey of housewives to govern civilian goods manufacture resumption. . . . As steel output rises, working force falls. . . . Welders have own versiou of "Four Freedoms." . . . Were you one of the 23,294? . . . "Said Jesse James to Jesse Jones—."

Is WPB passing out? . . . "One of the outstanding technological developments". . . . Feed the design engineers more "physicals" data on plastics. . . . Salvaging scrap in 26 easy lessons. . . . Pipe down on light metals—heaviness often a virtue. . . . The turtle wears a service ribbon. . . . The water sprinkler—magnetic nail remover. . . . Published price ceilings on alloying metals.

by Harold A. Knight
News Editor

"All (Relatively) Quiet on the Potomac"

"The difficult we do tomorrow; the impossible takes a little longer." This well-known war slogan is well exemplified in the case of our basic critical materials. One can now count on the fingers of a hand, which is shy one or two digits from an accident in the shops, the truly critical items, natural rubber being the first to come to mind, with paper a close second.

Thus, copper, until October, was on the WPB list of "most critical" materials, but is by now removed from that list. The zinc industry is certain there will be plenty of that metal. There are no longer fears concerning nickel.

And, thus, throughout the metal list there are indications of plenty, provided thrift is still employed. A year or so ago an adequate supply of metal seemed impossible — but, in the language of the slogan, this merely took "a little longer."

It was comforting to know we had steel shells and cartridge cases to fall back on, but they are not as satisfactory as brass. Steel shell makers recently shifted to brass.

Captain Norris H. Perkins, of Portland, Ore., told at the War Department Conference of Industry, Labor and Newspaper Leaders how in the Sicilian campaign a shell casing, corroded by salt air, failed to eject in a duel with German 88's, our tank thereupon falling prey to the enemy. Some radio equipment was also affected by salt spray, all of which indicates the need for the best metals in war equipment.

We Soft-Pedal the Unprofitables

Our metal supply is now so adequate that former feverish efforts to locate new deposits and mine potentials have become lukewarm. Moreover, no longer will our Government pay exorbitant premiums to marginal mine producers. If they cannot survive by their own economics they are not wanted. Furthermore, there is not the labor available to work doubtful mines.

The amount of ingot aluminum available each month is now 100,000,000 lbs. greater than consumption because of a dearth of fabricating facilities. Verifying the more plentiful zinc supply is the fact that one producer of high-grade zinc, who was formerly turning out 12,000 tons monthly, is down to 6,000 tons because of low demand.

As our metal supply improves the plans of our "political metallurgists" become more absurd, the latest being a program for steel plants in each of our 48 states. An earlier laugh was the proposal that brick plants produce sponge iron. We heard of one such plant that did produce sponge iron bricks — at a cost of 8 cents per pound.

Steel Scrap is "Comfortable"

"Present inventories of scrap at steel mills on the whole are comfortable, but in certain localities there is some deficiency," states the Steel Institute. "Consumption of scrap per ton of steel ingots is tending to decline because of greater pig iron production."

The present scrap drive is to insure against emergencies that might be brought on by diminishing manpower for collection and sorting, shortage of coal for operating blast furnaces, or drop in iron ore shipments.

Battlefield scrap will play an increasing role. It is presumed that

Germany remelts 100 per cent of her available battle scrap. England is said to be using 25 per cent of its battle scrap at least. In the United States, where urgency is not so great, we are more indifferent. It is said that 70-30 brass shell cases are difficult to dispose of because of contamination from lead, antimony and dirt from battlefields, most of this resulting from the primer. However, some scrap users are satisfied, reporting that spent shells come back clean, packed in their original ammunition boxes. Starting Jan. 1, new pennies will be coined from these shells. Scrap aluminum from wrecked airplanes is a drug on the market because of lack of manpower for proper sorting.

Our smooth war production is being more and more taken for granted —and what goes smoothly seldom gets into the newspapers. Peak aircraft production will probably be reached in February, coinciding with previous observations that we have about reached our limit for overall war production.

Resumption of civilian manufacture is one of the live topics. A nationwide consumer survey started Nov. 7 for the Office of Civilian Requirements, conducted by the Census Bureau. Enumerators then started to visit 7,000 households to ask civilians about the availability of 115 types of goods and services used in homes and on farms. This survey will guide in determining what civilian manufacture shall be renewed first.

More Steel With Less Manpower

Shortage in manpower continues more drastic than in materials or plant facilities. Yet, in time, the manpower shortage should be solved as is that in raw materials. It may be significant that the steel industry is ever making new production records with progressively less workers. In September, an average 620,000 employees were at work as against 625,000 in August, 640,000 in September, 1942 and 659,000 at the peak in June, 1942.

Now, to relax our face muscles after the serious discussion that has preceded, we'll present a bit of whimsy. First of all, there is no branch of the metals industry that is quicker on the trigger to see new opportunities than the welders. They are equally quick on the slogans.

The welders already have their "Four Freedoms" lined up (count 'em) — "Four Industrial Freedoms," they call them. Welding, they say, gives "freedom from excess weight, freedom from structural weakness, freedom for design improvements, and freedom to use new materials where they are best suited."

Do the welders have an Atlantic Charter, too?

Speaking of Tolerances

In a post-war survey in METALS AND ALLOYS *for October, it was revealed that one of the most universal lessons learned in war, to apply to peace, is manufacturing to closer tolerances. Precisely-made parts allow for interchangeability of parts, a department in which the United States has always led. Because of this, "cannibalism" is practiced widely on our battlefields — spare parts from incapacitated equipment are taken out to repair kindred armament.*

One reader suggests that if, indeed, manufacturing to closer and closer tolerances becomes an aftermath of the war, there should be a field day of activity for the makers of equipment for grinding, lapping, honing and inspection.

But to work up to the climax of this sketch, a manufacturer of gage blocks told us at the Chicago metal show that Army Ordnance will soon impose stabilization specifications on gage blocks where each block must be stable within two-millionths of an inch. That's a lot of zeros after the decimal point, brother! This gage-block-maker attains his own block stabilization or seasoning by alternate heat treatments and freezings as cold as minus 120° F.

Metal Carnival at Chicago

Ah, yes — the National Metal Congress at Chicago! Official attendance was 23,294, all of whom were standing in line at the Palmer House the opening day, waiting to be assigned to rooms reserved several months before — at least, so it seemed.

Attendance at the technical and semi-technical sessions was greater than ever before, showing an earnestness to pick up useful information.

At the technical sessions, speakers pulled their punches because of war secrecy, which was somewhat disappointing, but the other sessions offset them because of better calibre than usual. A post-war flavor rampaged all over the place, as has been noted at other fall conventions.

One saw less gaiety and frolicsome cavorting around, partly because of the sedate character of the Palmer House, partly because of the serious era in which we live.

The exposition, on three floors of the Palmer House, housed in bed rooms, was in one respect an all-time novelty record — the first time in history that each "booth" has had an adjoining bathroom, complete with shower. The richly carpeted floors were bad for the sellers of foot-ease, they who had done a thriving business in the old days of cement floors.

But, no fooling, the exposition was better than the cash customers had anticipated. There was plenty of light equipment, exhibits, photographs, samples, moving pictures and attractive displays.

The usual hand-outs were being passed around freely: Notebooks, paper briefcases, matches and paper Scotch hats. (We obtained one of our own MacDonald clan, father's side.) And don't forget the glamor girls here and there to give welcome contrast to the more drab equipment!

Will WPB Pass Out?

Resignations in the upper echelons of the War Production Board — actual, contemplated, and rumored — indicate that the "fifth wheel" of the nation's production effort nears total discard. Basically, the elements of war production have always been the Army, Navy, Maritime Commission, and the manufacturers.

The superimposition of the Office of Production Management, its successor the Supply Priorities & Allocation Board, and, in turn, the WPB on the production program has been a source of deep conflicts and confusion, and in many instances has caused delays.

Charles E. Wilson, who returns as president of General Electric Co., is known as a clear-headed planner — with his eyes turned toward the future. High WPB circles are talking of his heading a Government "reconversion" program to "control the process of industry getting back to peacetime production."

Industrialists generally hope that this task faced by industry will not be confounded by Government controls. All they are asking is that the Army, Navy, Maritime Commission and other Government *procurement* agencies be permitted to set policies for contract cancellations that will not bankrupt America's manufacturing industries.

It is probable that Mr. Wilson could make a contribution to the immediate post-war problem, but the prospect of WPB continuing through this period is a depressing one.

Two Jesses Hold a Tete-A-Tete

by V. M. McConnell

(News item: The United States, through the Reconstruction Finance Corp., will own by the war's end 10 per cent of the nation's steel capacity, 50 per cent of the machine tool, 50 per cent of the aluminum, and 90 per cent of the magnesium capacity.)

Said Jesse Jones
To Jesse James:
"Through R. F. C.
The New Deal claims
The perfect right
To burglarize
The realm
Of Private Enterprise."

"I tried that once
Without success —
That's why they wiped
Me out, I guess.
And now I'm only
Mouldy bones,"
Said Jesse James
To Jesse Jones.

Outstanding Technological Method

"One of the outstanding technological developments of the year is precision casting," states Joseph Robinson, Industrial Processes Branch, WPB's Office of Production Research and Development. "In the fabrication of small parts it is a heavy saver of metals, tooling-up expenses, machine tool equipment, and manhours.

"From very small non-ferrous castings, true within 0.001 in., to turbosupercharger wheels of vitallium cast in one piece, 13 in. in diam., weighing about 8 lbs., precision casting is serving the war effort with great benefit and promise. The foundry and machine shop are, so to speak, joined in the one art." (Vitallium is chiefly nickel and molybdenum.)

Tell Engineers the "Physicals"

Despite glib prophecies of postwar use of plastics, newspaper Sunday supplement writers and starry-eyed oracles have missed a point that interests design engineers, namely: What are the physical characteristics of these chemical marvels?

Nearly 50 outstanding designers of automobiles, house furnishings, and other durable consumer goods interviewed in recent weeks by METALS AND ALLOYS raised the question: "What will these plastics do?" All of them want more engineering data on structural, tensile, shear, and compressibility strengths.

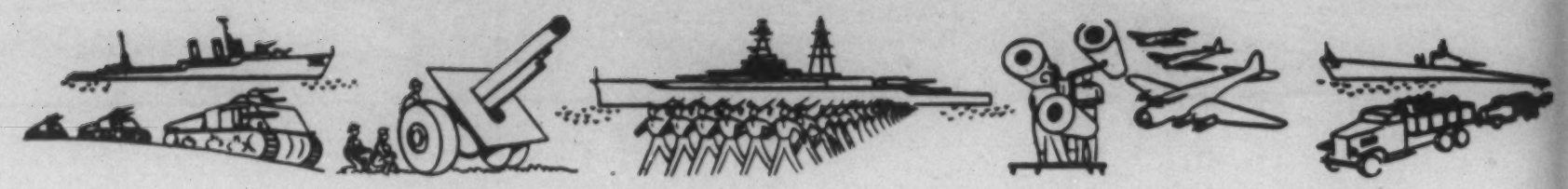
Characteristics of warping, the elastic limits, and more details as to improved manufacturing processes are needed before designers will dare to specify plastics.

It is true that most plastics producers have prepared and are still preparing characteristic data on a wide range of plastic materials to help design engineers. One trouble may be that though the "physicals" of plain materials are known, data on the same material in components or semi-fabricated forms are not so complete. It is also a matter of education. Perhaps more advertising space should be devoted to essentials with less emphasis on glamor.

Similarly, too little is known of the physical properties of synthetic rubbers, design engineers agree. As the state of the art now stands, optimum results can be had by careful selection of the compositions of a material, and best results may be had only upon specifying particular compounding for a given part.

But the manufacturing industry expects to have enough experience within the near future to guide design engineers. It appears that reclamation of synthetics is possible, and may be practicable with the improvement of processes now being developed.

Chief engineers and engineering managers who are in charge of design projects generally believe that penny-slicing will be paramount for the post-war period. The predicted



post-war capacities of the light metals and alloy steels strike most of those interviewed as academic in the extreme without some idea of prices of raw materials.

Low carbon steels will have a price advantage even if the Government plant capacities are made available to industry on a dollar-per-year basis.

Salvage Manual for Industry

Here at least the Government has used print paper to good advantage, 245 pages per book, in the *Salvage Manual for Industry*. This book not only has its feet on the ground, but its hands in the scrap bin, apparently written by men who know the subject.

There are 26 chapters, 6 major sections. Among the many topics are organizing and planning the salvage department, administrative factors, methods of handling, finding, identifying, segregating, collecting reclaiming, storing, selling, etc. There are case histories demonstrating exemplary practice.

Seven editors are listed on the title page. There are plenty of illustrations. Too bad it wasn't published earlier. It is sponsored by the WPB, and is for sale by the Superintendent of Documents, Government Printing Office.

Passing Thought on Heavy Metal

In view of all the ballyhoo about the future of light metals, justified as it may be, it was refreshing to have called to our attention that lightness of metals is not always the height of desire.

Thus, lead is often used because of its concentrated weight characteristics. There is the current large-scale use of lead in ammunition because lead gives concentrated weight in small arms ammunition and, therefore, highly desirable ballistic properties.

Again, lead is used in naval vessels as ballast. Oddly enough, lead is also used in one application where the reduction of excess weight is a paramount objective — lead counterweights to help operate rudders and ailerons in airplanes. Lead is used as a counterweight in anti-aircraft artillery, for the keels of certain ships, and as a fishing line sinker for aviators forced down into rubber boats.

Such was the message of Felix E. Wormser, secretary, Lead Industries Assn., before the American Society for Metals at Chicago, October 20.

He stated that 10 per cent of the current use of lead is because of this concentrated weight characteristic; 30 per cent of the uses are by virtue of its softness, malleability and high corrosion resistance; 24 per cent because of its alloying properties; 33 per cent for its chemical compounds; with 3 per cent unclassified.

Tortoise Won Out Over the Hare

Man often accomplishes his best when he studies and copies nature closely. Some ten years ago we heard a most interesting automobile designer explain how his company chose brilliant colors for bodies and harmonizing upholstery, for that was an era of gay automobiles. He borrowed most of his color combinations from nature, *i.e.* from the tropical fish in southern waters.

Another stunt, which he demonstrated before us, was to activate an ordinary-looking gray rock with ultra-violet rays, and behold! — most gorgeous, yet unearthly, colors emanated therefrom and dazzled us all. Nature seldom makes a mistake.

And now in wartime, Army Ordnance has studied the lowly turtle and has learned therefrom the law of firestreaming as applied to tanks, whereby bullets and projectiles glance off the protective armor, copied from nature.

We recall a visit to Aberdeen Proving Grounds last March, where in a bitter cold wind off the Potomac we witnessed a parade of tanks. The early models loomed up like Robin Hood's barn and elicited from our lay knowledge a sickly laugh of derision.

But now — to give credit to the *Army News* for their facility for whimsical statement: "The lowly turtle is now wearing an Army Ordnance service ribbon."

Our Own Post-War Patent Pending

Perhaps one of the first post-war applications of wartime equipment will be the magnetic nail-from-roadway-picker-upper. Familiar by now are the mobile magnets that do a two-fold job of removing steel from plant floors and roads, thus saving tires, and salvaging steel. The Ontario Department of Highways has already patrolled the highways with such a contraption.

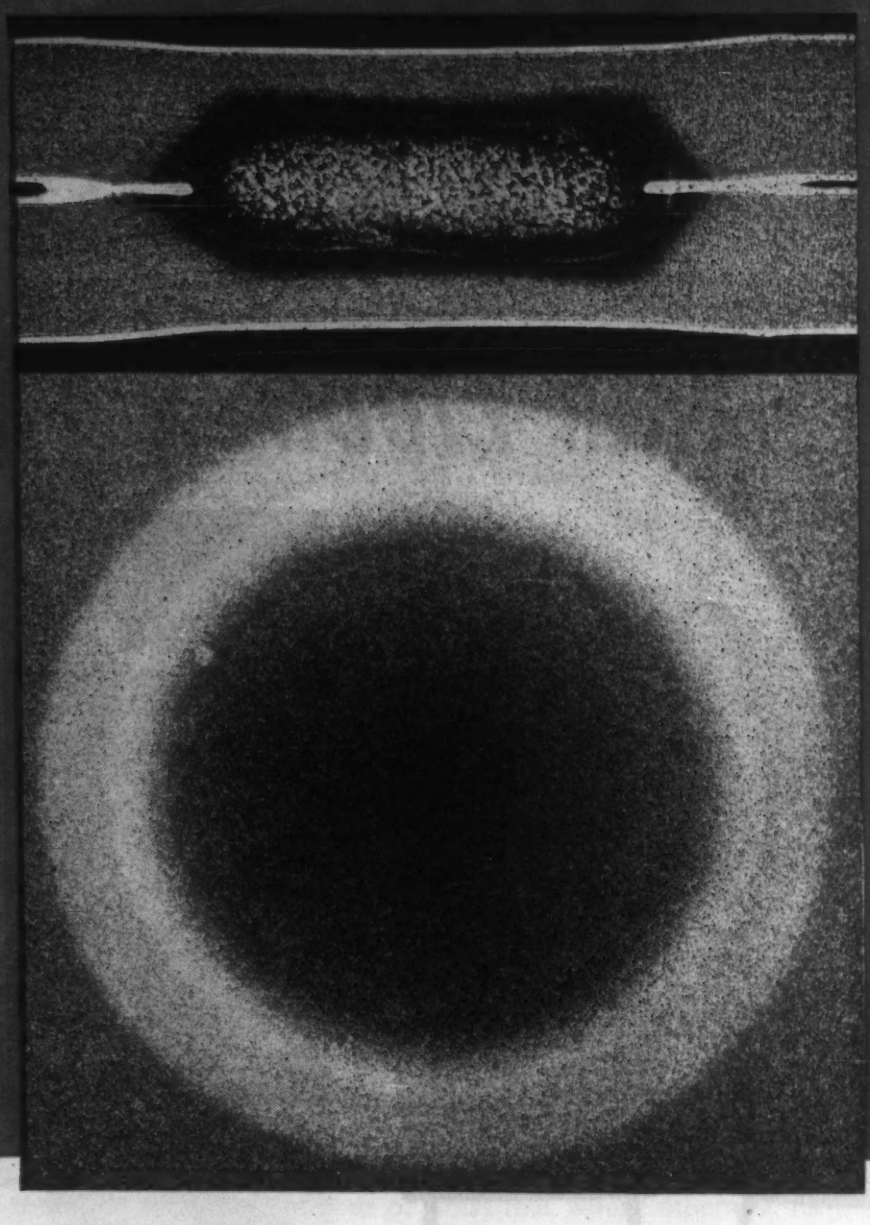
Now we propose to go a step further. We'll provide all municipal and Government work vehicles, such as road sprinklers and snow plows, with magnets. A village financial report of 1946 will read: "Expenses of road sprinkling for fiscal year, $106.30; income from salvaged steel, $6.30; estimated tire life prolongation, $1,006.30."

Price Ceilings on Alloying Metals

To make prices better known to consumers, a specific regulation providing definite price ceilings for several alloying metals used in steel is announced by O.P.A. Previously, ceilings were the highest prices that individual sellers had charged in March, 1942 (or over the first quarter of 1942).

Here are some of the new ceilings: Ferrotungsten, $1.90 per lb. of contained tungsten for 10,000 lbs. or over; ferromolybdenum, 95 cents per lb. of contained molybdenum; molybdic oxide and calcium molybdate, 80 cents per lb., contained molybdenum; ferrovanadium, open hearth, $2.70; crucible, $2.80; primes, $2.90 per lb. of contained vanadium; cobalt metal for metallurgical use, $1.50 per lb. in kegs, 500 to 550 lbs.

How good is that *Spot Weld?*



Above: Micrograph of cross section of spot welded Alclad 24S-T sheet. 10X. Below: Radiograph of the same weld, enlarged to diameter equal to the above.

Metallographic examination tells you how good a spot weld you've made, but it destroys the sample. Radiographic inspection is nondestructive. Employ both methods, therefore, to establish good welding procedures. Then use occasional radiographic inspection to check production.

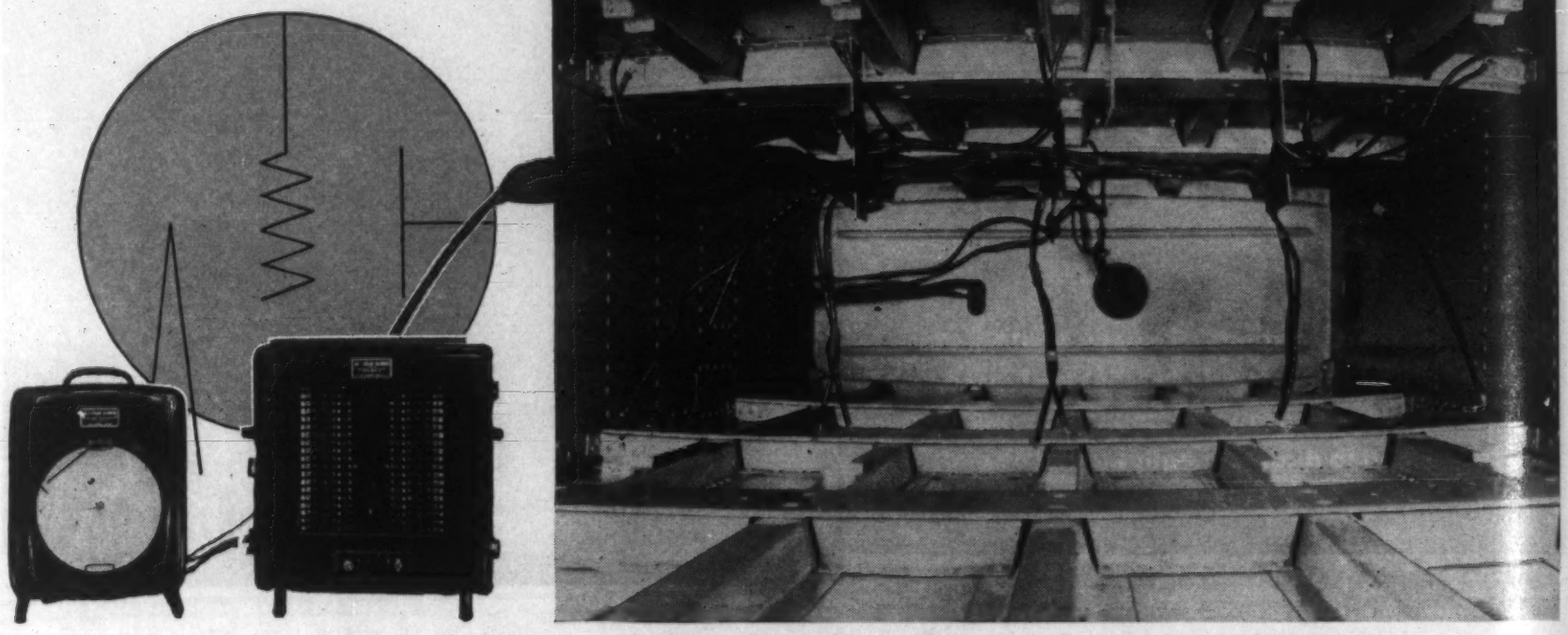
Size of the weld nugget, shape, soundness and freedom from cracking are the characteristics which have the most influence on the performance of a spot weld. Radiographs can be made so that they disclose these details.

Techniques for producing good resolution in radiographs have been developed at Aluminum Research Laboratories. Information on these practices is offered by Alcoa to all fabricators of aluminum alloys to enable them to improve their products.

Send for the paper, "Correlation of Metallographic and Radiographic Examinations of Spot Welds in Aluminum Alloys." It describes methods used and results obtained. Write ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

NEW PROGRESS
in Instrumentation
with *Electronic Sensitivity!*



Measuring strains in airplane wings is one typical use of electronic instruments developed by Foxboro. Electronic Recorder, at left, gives exact, rapid readings of 48 SR-4 strain gages located inside wing, as shown above.

Initial successes foretell industry-wide application of *DYNALOG* Electronic Instruments!

Again, the first "milestones" to an important new phase of process measurement and control have been established by Foxboro. This time, it is through successful "key" applications of *electronic sensitivity* in instruments to give new degrees of manufacturing precision!

For more than eight years, Foxboro Verigraph Electronic Instruments have been widely used by rubber and paper industries for sensitive weight-and-moisture measurements. Continued original research has brought new developments in Foxboro electronic instrumentation.

Today, in war-essential installations, electronic instruments by Foxboro are making instrument history . . . measuring strains with unique speed and accuracy . . . furnishing continuous precision records of torque . . . keeping track of temperature with exactness never possible before!

Tomorrow, when peace returns, Foxboro's new DYNALOG Instruments will be available to all industry for these and other important applications. DYNALOG Instruments will vastly simplify many difficult process control problems . . . will furnish the first practical instrumentation ever developed for some industrial operations!

A STAR IS ADDED . . . For continued outstanding production, The Foxboro Company has won renewal of the Army-Navy "E" Award.

The Foxboro Company, 54 Neponset Avenue, Foxboro, Mass., U. S. A. Branches in principal cities.

DYNALOG **measurement and control by** **FOXBORO**

Reg. U. S. Pat. Off.

Steel vs. Brass for Cartridge Cases

We have heard some comment in recent weeks concerning what is described as excessive publicity given to the steel cartridge case program or as a tendency to exaggerate the facility with which steel cases can be produced and their serviceability in combat. This has usually been accompanied by assertions that the steel cases have not lived up to expectations and that—in contradistinction to being our No. 1 engineering achievement—they are actually our most formidable war-production headache at present.

In the first place neither we nor the fabricators of steel cartridge cases have ever had illusions about the relative merits of brass and steel for cartridge cases. For a variety of reasons—military, production and economic in nature—brass is the ideal material for this application, and however far the steel cartridge case program has gone we have yet to hear a manufacturer say he would rather make or a combat officer say he would rather use steel cases in preference to brass.

But the number of cartridge cases required for our armament program was too great and the amount of brass available too little to permit the use of brass for all case requirements. So ordnance and industry got busy and succeeded after much study, sweat and swearing in developing the steel cartridge case (heat-treated as well as cold-worked, incidentally) as a satisfactory *substitute* for brass.

That we considered this no easy task is clearly indicated by our classing the steel case program as a major engineering achievement and by our use of such phrases as "by no means easy to solve," "baffled the investigators of other nations," "imposing obstacles to fabrication in steel," etc. in editorial comment on Colonel Turner's article in METALS AND ALLOYS for October. The steel case is not a better case, and with all the obstacles to its manufacture that were overcome, the steel case is still more difficult to make, than the brass. But it has done the job it was developed to do—to replace hundreds of thousands of tons of brass that would otherwise have had to be used, but which thus could be employed for other purposes—and thereby made an enormous contribution to winning the war.

As brass becomes easier in supply the steel case program will certainly be cut back. The steel case constituted a successful expedient that many will be happy to abandon as soon as feasible. But this is no denial whatever of the great achievement in making that expedient possible and useful and in the contribution to conservation it represents.

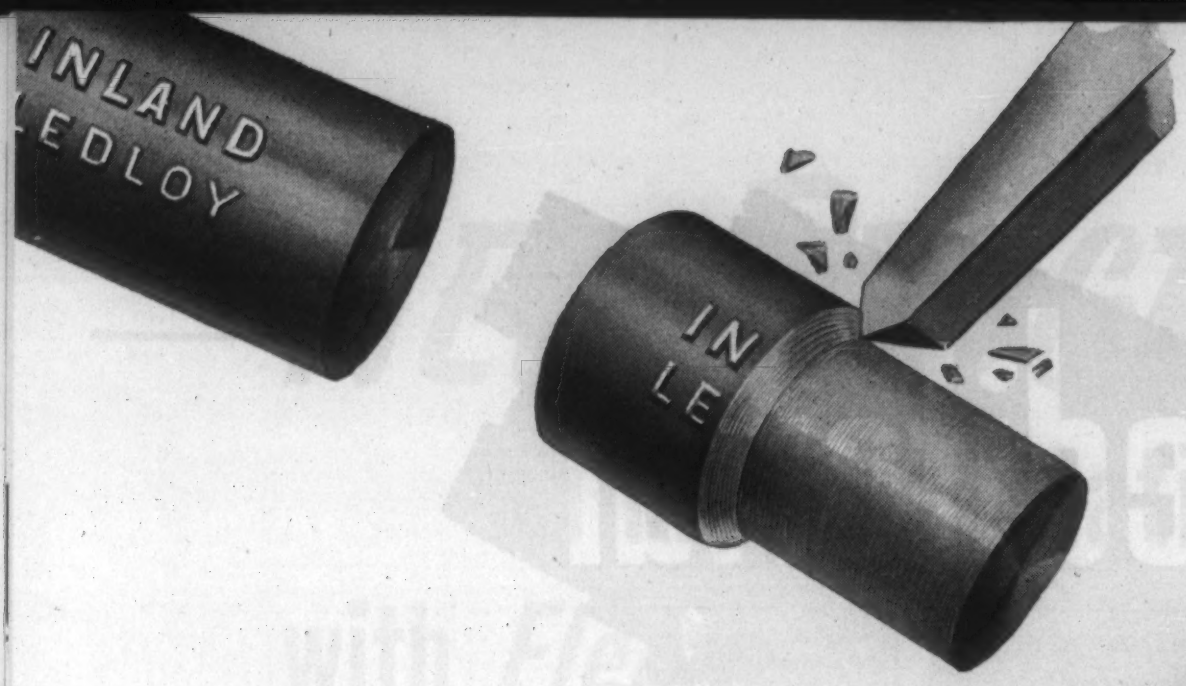
And quite aside from the brass-vs.-steel discussion, our engineers and metallurgists have learned things about drawing steel they merely suspected or never knew before—things that are certain to have important implications for the design and manufacture of many post-war products. —F. P. P.

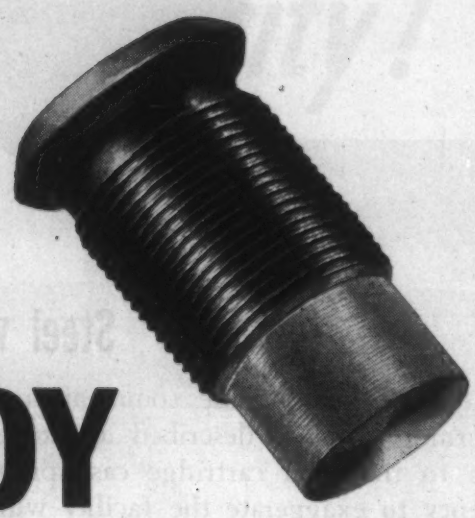
Electric Furnace Steel

Evidence is rapidly accumulating to show that the American electric steel industry is expanding beyond the expectations of many optimistic observers and that it is assuming a commanding position in the steel industry as a whole. Illustrative of this trend, several facts may be cited.

In October a new total output — 413,787 net tons — for any month was achieved. This is at the rate of nearly 5,000,000 tons per year or an increase of about 1,000,000 tons over the 1942 total. To Nov. 1, this year's total is about 600,000 tons in excess of that for the same period in 1942.

The increase in output for each quarter of the year since January 1942 has been progressive — from 898,000 tons for the first quarter of 1942 to 1,191,800 tons for the third quarter of 1943 with the





Higher War Output Results from

INLAND LEDLOY

—the lead-bearing, faster-machining, low unit-cost steel

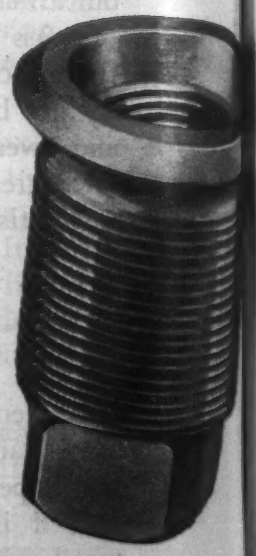
Increased production up to 110%—tool life lengthened up to 300%—these are the principal results obtained in America and in England, where Inland Ledloy is used for wartime parts production.

Inland Ledloy is open hearth steel containing a small percentage of lead, which is uniformly dispersed and alloyed with the steel by a special Inland process. This addition of lead *greatly improves machineability*. Except for its slightly finer grain structure, all physical properties of Ledloy—yield strength, ultimate strength, elongation, reduction of area, resistance to impact, etc.—are the same as for open hearth steel of similar analysis.

Welding qualities are comparable with those of ordinary carbon steel. Ledloy is easily forged, giving sharp, clean, die impressions. Methods used and results obtained when heat treating and carburizing are the same as for steel of similar analysis, except for the effects of the slightly smaller grain structure.

Today, all the Ledloy that Inland can make is being used to speed up war production. But when peace comes, Ledloy will again be available for general manufacturing use—to speed up output, and to cut unit cost.

Write for further information on Inland Ledloy.



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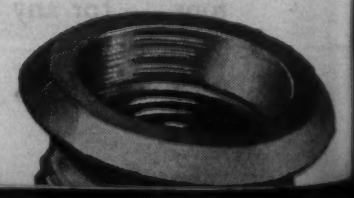


prospects of about 1,250,000 tons for the closing three months of 1943.

Authoritative data recently made public show that there are over 700 furnaces making electric steel, both ingots and castings, in the United States. Over 500 of these are reported in steel foundries. In some plants the use of electric furnaces in duplexing or triplexing practice has expanded markedly in the last year or two.

These facts or trends explain in part the reasons for the organization of an Electric Furnace Steel Committee by the Iron and Steel Division of the A.I.M.E. paralleling the Open-Hearth Steel Committee of the same society. The new committee held its first convention this fall and it was highly successful, over 400 electric furnace operating men, engineers and metallurgists attending.

There was ample justification for the organization of an open-hearth committee — convincingly demonstrated by its splendid work during the last 25 years. The growth, however, of the alloy steel industry has been in large measure responsible for the expansion of electric steel. It is therefore highly appropriate that this new committee should function. The fact that the major portion of our alloy steel output is and will be made in electric melting units and the fact that the first convention was so successful fully justify the new organization. Its deliberations at conventions, if the attendance is as representative and cooperative as in the case of the open-hearth meetings, will solve many problems peculiar to electric furnace practice and be highly beneficial to this important phase of steel technology.

—E. F. C.

Plants With Fancy Pants

The expression, "He has fancy pants," usually conjures to mind a chap who carries lots of the tinsel and glossy glamor of life; a fellow whose feet are not on the ground but whose gay and giddy mien hides that fact, at least for a while. We wonder to what extent the industrial plant of today wears fancy pants. Thus the Jack & Heintz works in Cleveland has been written up so frequently as to be familiar to all, what with its swimming pool, billiard rooms, music, informalities and club room life generally.

Radio and phonograph entertainment, floor shows, brass bands, kindergarten care for children, cafeterias, sun lamp rooms, periods of calisthenics, etc. would certainly make some Rip Van Winkle coming back from the era of the "Gay Nineties" rub his eyes with wonderment.

A plant in Illinois boasts an Employees Service Bureau. Here plant officials attend to and solve such vexatious routines as handling gasoline and special mileage applications; purchase of new automobiles, bicycles, tires, tubes and similar items; listing and investigation of rooms, apartments and houses; purchase of war bonds; automobile licenses and tickets for social functions; and assistance with a variety of miscellaneous problems.

Undoubtedly these fancy pants ideas were due to the competition among industrial plants to get war workers, as well as to the desire to enhance worker morale and boost production. In the private home the lady of the house has made the same or similar concessions to keep a maid. It is plainly an employee's market. But what will happen when the wars are over and it becomes an employers' market?

Many of the innovations are here to stay. Certainly a cafeteria with good and plenty wholesome food, light and airy shop surroundings, machines which take less brute strength to operate, comfortable rest rooms for both sexes, are essentials in the modern way of looking at things.

Yet beyond that it is best not to try to plan too much of the employee's life and convenience. The ordinary man gets a certain amount of pleasure in working things out for himself. Too much paternalism is patently harmful. Most individuals wish to choose their own entertainment. Moreover too much sociability with the same fellows palls. The present jazzed up plant life harmonizes with the excitement of the war and the desire to keep morale at fever pitch.

But certainly we may expect that without serious harm to anyone the post-war plants will change those fancy pants to trousers a bit more restrained.

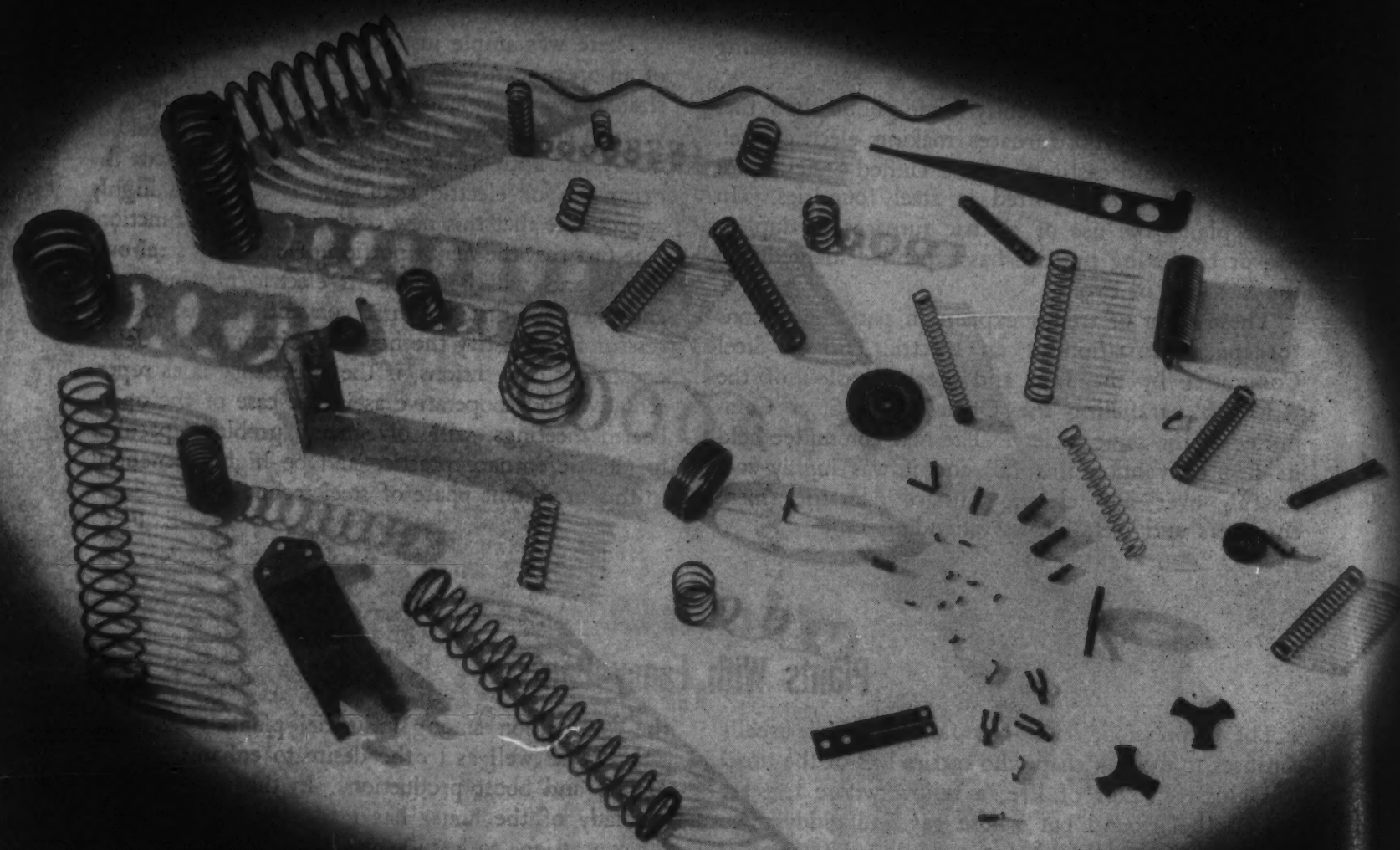
—H. A. K.

The Steel Companies and War Profits

Not often but once in a while one hears the accusation that some of the metal companies, particularly the steel, are wallowing in high income and war profits. Such statements may have been true in World War I, but they are not verified by the experience in *this* struggle. It might be expected that such a statement could be based on substantial facts for this is a war of metals—steel, aluminum, magnesium, copper and so on.

A recent report of the American Iron and Steel Institute, covering the first half of this year, shows that earnings of the steel companies dropped 8 per cent below the corresponding period of last year, and were 40 per cent less than the earnings in a representative peacetime year like 1937. Other facts in this report revealing the trend and some of the causes, include the statement that indicated return on investment

(Continued on page 1342)



A group of a variety of springs made of beryllium-copper.

Making Beryllium-Copper Behave

By ROBERT W. CARSON

Vice President, Instrument Specialties Co., Inc., Little Falls, N. Y.

Romance has dogged the path of beryllium-copper —and contributed many of the headaches retarding its adoption. One of the war-period's major engineering achievements has been the development of methods of treating and testing beryllium-copper that have transformed it into a uniformly dependable and superior material and assure it a permanent place in post-war developments. Here is the story of its halting development in this country and an outline of what can now be done with the material once its advantages (and limitations) are better understood.
—The Editors.

BERYLLIUM WAS DISCOVERED nearly 150 yrs. ago, but it did not get beyond the laboratory stage until about 1925. Being one of the light metals, about the same weight as magnesium, beryllium was first looked on as a light-weight structural metal, but its brittleness limited the use of the pure metal. Its alloy with copper was first studied in Germany in 1916 but the remarkable age-hardening properties of a 2-per cent beryllium-copper, alloy were not discovered until 10 yrs. later.

Precipitation-hardening properties of beryllium-copper were uncovered in an interesting way. Masing

in Germany was studying the phenomena of dispersion or precipitation hardening as exhibited by copper-aluminum alloys and concluded it was a function of solubility varying widely with temperature. Searching for another alloy of similar characteristics to check his theory, he ran across a phase diagram published some 10 yrs. earlier on beryllium-copper. This alloy had the right type of solubility-temperature relationship, and he began experimenting with it. The experiments were successful. Using X-ray diffraction, and measuring changes in volume, conductivity and modulus, Masing was able to prove that his theory was valid.[1] As a by-product the age-hardening properties of beryllium-copper were discovered.

Early Work on Beryllium

When the news about the age-hardening properties of beryllium-copper arrived here, quite a bit of work had already been done and reported on beryllium as an alloying element for copper.[2] This early work, some two or three years before this discovery, was concerned primarily with the properties of a copper alloy with beryllium as a possible substitute for zinc or tin. Mill practices required for fabrication, and physical properties obtainable from cold worked material were reported in some detail, but the then high cost of extracting pure beryllium stood in the way of commercial production, and the investigation was dropped.

But now the picture was changed. Instead of being only a substitute for tin or zinc, beryllium made possible an alloy with far superior properties, particularly for springs. During the following two or three years the technical and popular press gave beryllium-copper quite a play. Much was made of the potentialities of this "hardenable copper" and the discovery of the "lost art of the ancient Aztecs." Popular writers waxed romantic; beryllium-copper became the "wonder metal," and a great and glowing future was freely prophesied for this alloy.

Behind this rosy glow there was fortunately some reality. Laboratory research reported by J. K. Smith in 1932 on an alloy containing about 2.50 percent Be established mill procedure and confirmed the unusually high properties obtainable by precipitation hardening.[3] Smith used a solution heat treatment at 1450 deg. F. followed by quenching. The age-hardening effect on both annealed soft and cold worked material was investigated using a hardening heat treatment of 570 deg. F. for 2½ hrs. in an air furnace. A study was also made of physical properties of over-aged (7 hrs. at 575 deg. F.) and cold worked alloy. However, (quoting Smith) "No attempt was made to explore the time-temperature ratio which would be expected to exist," and from this time the hardening temperature was 575 deg. F.

At about this time a much lower cost process was developed for getting the beryllium into the copper, by-passing the expensive process of producing pure beryllium. This process, carbon reduction, converted beryllium oxide, powdered carbon and powdered copper to a "master alloy" of about 4 per cent Be in copper, which was then remelted with additional copper to produce a 2 to 2.25 per cent alloy.

It was then (1934) quite apparent that beryllium-copper would make an outstanding spring material with commercial possibilities. Two non-ferrous mills announced they were ready to supply the alloy and booklets describing its properties were published. Looking back from what is now known about beryllium-copper, it is evident, however, that not enough attention was given to the effect of a temperature higher than 575 deg. for the hardening heat treatment in obtaining better spring properties. Most of the laboratory work had been done on standard test bars of relatively large section as compared with stock sizes required for springs, and the effect of size or mass as well as the character of cold work was not given proper weight.

Conventional Heat Treatments

Three other factors also had a bearing on the early adoption of a low temperature for the hardening heat treatment. Tests made on standard laboratory test bars showed that hardness and tensile strength were critical as to time at temperature when hardened above 575 deg. F. This, of course, was a disadvantage for any heat-treating department doing their first work on beryllium-copper. The second factor was that at higher temperature (which resulted in more complete precipitation-hardening) the elongation dropped, and in usual brass mill products this

Flatness in this punch press part is established and held by the pressure exerted on the part by the heat-treating fixture.

of course is undesirable. Third, variations in response to heat treatment in the material as supplied by the mill were much more marked at higher hardening temperatures. As a result, heat treatments in the range from 550 to 575 deg. F. in an air furnace for 1 to 2 hrs. were usually recommended. Although the final spring properties were not as high as obtainable, these compromise heat treatments were incorporated in ASTM standards[4] and accordingly received wide acceptance.

During this early period there was quite a bit of talk about the exceptional endurance strength of beryllium-copper, which was in fact supported by a few scattered early tests. However, the one laboratory investigation, made and reported in 1937,[5] found results far below the expected values. From our present knowledge of the alloy, the failure to develop expected properties is readily understandable. First, the investigation was made on specimens heat treated in accordance with ASTM specifications, 2 hrs. at 575 deg. F., a temperature now known to be too low to bring out maximum endurance strength in spring temper material. Second, the specimens were annealed before age-hardening, thus losing all the beneficial effects of cold work in improving endurance.

But it certainly was recognized that beryllium-copper had exceptionally fine spring properties. It could be formed in the soft condition and then hardened. It had the corrosion resistance of bronze and the strength of steel. It was non-magnetic, high in thermal and electrical conductivity, more resistant to heat than bronze and did have higher endurance strength.

Drift—A Critical Spring Property

Because beryllium-copper offered such high promise as an instrument spring for precision applications, it was investigated by the author in 1933 for drift, hysteresis or aging characteristics. These effects are a serious disadvantage for precise or calibrated instrument springs, since any tendency to drift or take a set under load, or to change calibration or zero position with time is undesirable. Drift is the term usually applied for such errors and is conveniently measured by holding the spring under a constant load for a period of time and noting the gradual change in length under load. Upon removal of the load the spring fails to return at once to its former free length but continues to recover or approach its original length over a period of time.

In connection with certain instrument spring problems, a number of spring materials had been studied for their drift and inelastic effects and an instrument had been developed for measuring drift in springs.[6] Shortly after beryllium-copper first became available, some heat-treated spring specimens were tested in the author's laboratory. This was during the "wonder metal" period and the work was undertaken with high expectations, but no exceptional drift properties were found in this initial investigation. To facilitate the preparation of additional specimens a small salt bath heat-treating furnace was set up, and the experiments were continued on specimens made from material having a greater degree of cold work.

In one of these experiments the beryllium-copper specimens were placed in a salt bath which through an error was at too high a temperature. This was discovered in a few minutes and the pieces removed, presumably spoiled. But they were tested anyway, and surprisingly were found to have far less drift than any specimen of any material previously tested. An immediate investigation was made disclosing that far superior drift properties could be obtained with a high temperature short-time heat treatment in a salt bath. The drift was so low in fact that the existing drift testing equipment did not have sufficient sensitivity to make the measurements.

Still working in the laboratory, efforts for the next few months were directed largely toward finding a more sensitive drift measuring method. The early equipment for measuring drift consisted of a micrometer head for measuring the deflection of a cantilever specimen under a gravity load, and a grid glow tube for indicating contact between micrometer tip and the specimen under test. Although the contact current was extremely small, yet some arcing and pitting did occur, which resulted after a period of operation in some contact pressure being required to get a contact indication, and accordingly introduced errors in measuring drift.

The desired performance was finally obtained by the use of an electronic circuit in which the contact current was reduced to zero.[7] (Not only did this solve the drift measuring problem, but it also made possible a production spring tester of extreme precision and a line of pressureless measuring instruments for soft or compressible materials.) With the greater sensitivity of the new Electronic Micrometer for measuring drift, it was possible to develop a still better heat-treating procedure and an extensive study of the factors affecting drift was undertaken.

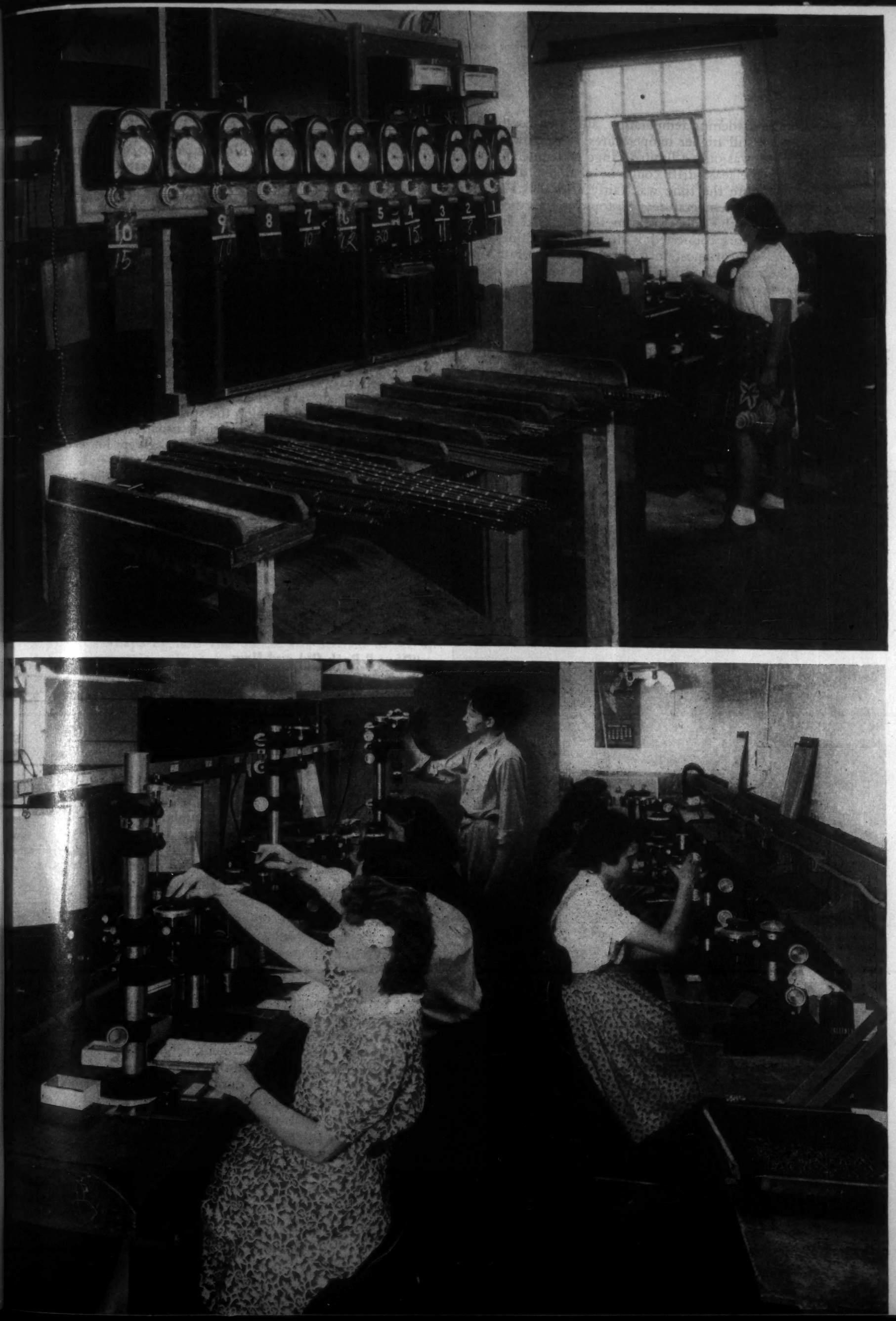
Heat Treating for Minimum Drift

This investigation disclosed that minimum drift for any one lot of beryllium-copper springs could be obtained only with one combination of time and temperature. At any one temperature the drift rate decreased with increasing time until a minimum point was reached, and then increased with additional heating time. Hardness or tensile strength alone could not be used to determine the point of minimum drift. As shown in Fig. 1 for a typical test, the hardness changed little or none over a range of time in which the drift changed as much as 300 per cent.

Running drift tests on specimens heat treated at higher temperatures disclosed that the rate of drift (at the minimum point) became less up to some

To apply heat-treat forming to compression springs (upper right), wire is automatically coiled on steel mandrels and heat-treated while held on the mandrel. Each individual lot has its own hardening time and temperature as established by tests on the incoming material.

Set or drift tests are regularly used as production control check on the hardening heat-treatment; with tests being made at frequent intervals on the product of every coiling machine.



critical hardening temperature, and then became larger with still higher temperatures. As shown in Fig. 2, there was only a limited range of temperature over which the least drift could be obtained, and at this temperature the time was fairly critical. The minimum drift temperature was found to vary considerably with the cold work in the material and with other factors connected with mill fabricating operations, but for most lots tested the temperature was in the range of 650 to 700 deg. F. with time at temperature from 10 to 30 mins.

Correlating other spring properties with drift, it became evident that beryllium-copper spring stock, heat treated for minimum drift gave the one condition under which all the more important spring characteristics were at their best. Tensile strength and proportional limit were at or near their maximum, nearly all the modulus change had taken place, and endurance strength was at its peak. It was true that elongation was low, and the material broke with

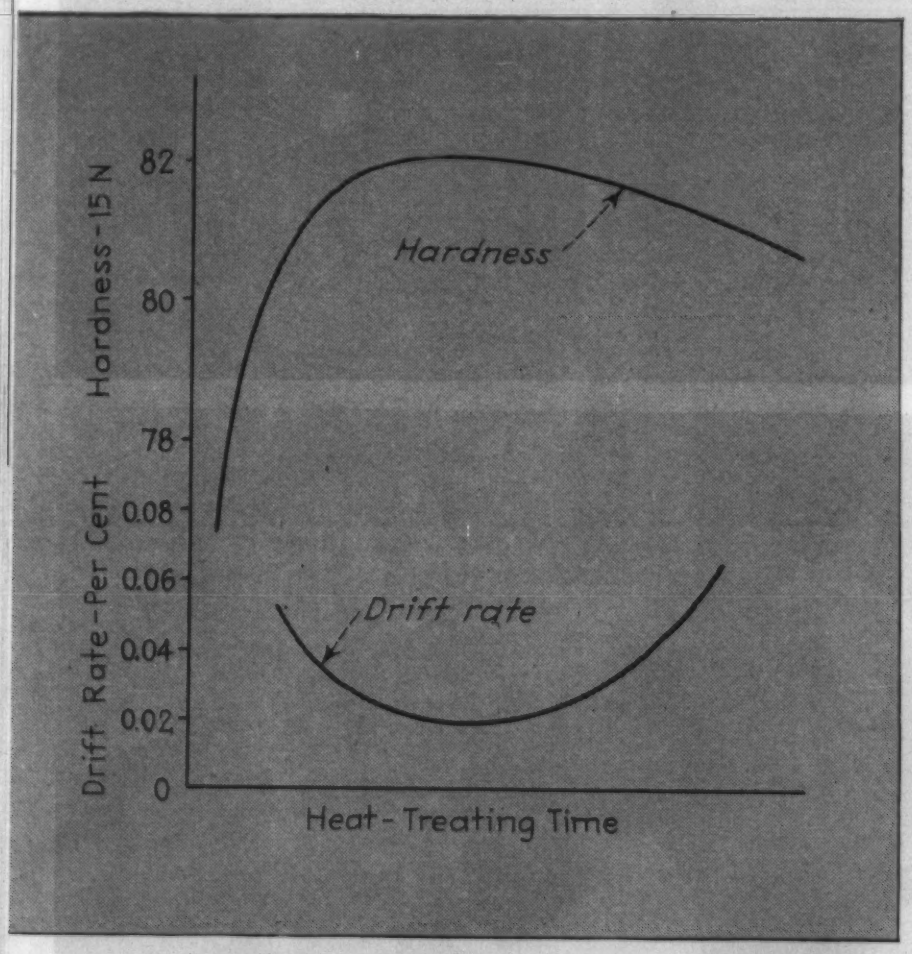


Fig. 1. Measurement of drift in beryllium-copper spring material accurately determines the proper heat-treating time for best overall spring properties.

a brittle fracture much like hardened spring steel. This brittleness, however, was of no disadvantage for spring applications since any overload resulting in fracture would stress the spring far beyond any safe working limit.

It is not too clear just why beryllium-copper exhibits this exceptionally high stability or freedom from drift. The best explanation offered has to do with relief of internal stresses. There is quite a bit of drift-measuring background in work on other spring alloys establishing a definite relationship between reduced drift and relief of internal stresses. Of all spring alloys, only beryllium-copper can be heated at a temperature high enough to give complete stress relief without loss of desirable spring properties.

Microscopic examination of beryllium-copper shows that the 575 deg. F. heat treatment does not wipe out slip lines while the higher temperature does. There is therefore some justification for the idea that a hardening heat treatment in the range of 700 deg. F. causes some fine recrystallization which of course would eliminate internal stresses. This would also explain why endurance strength is improved by the minimum drift heat treatment.

The temperature and time required to obtain minimum drift, and along with it the best spring properties, will vary over a fairly wide range from lot to lot of material,[8] as well as with the amount of cold work introduced in forming the spring. In any given mill run of material the variations usually are small, and any one run of springs from a given lot can usually be heat treated alike.

If any variations are present in the stock, they can be found readily by running a hardness-time curve such as shown in Fig. 3 at a temperature somewhere near the expected minimum drift point. At these higher temperatures the hardness-time curve is quite sensitive to small variations in the heat-treating response, and if the hardness curves are alike—say for all coils in a shipment—then a drift test will be needed only on one coil. But a standardized heat treatment will only work by accident.

"Bugs," Both Old and New

With this knowledge of how beryllium-copper responds to heat treatment, some of the earlier difficulties with the lower temperature heat treatment are understandable. In the past the typical approach in developing a beryllium-copper spring application has been to obtain a small lot of material and produce a few hand-made samples. These samples usually were carefully heat treated under engineering or laboratory supervision, at some standardized time and temperature. If the standard heat treatment failed to give desired results, a new heat treatment was worked out and written into drawing or heat-treating specifications. These trials often gave such promising results that the engineer behind the job built up high hopes for beryllium-copper.

But too often trouble developed when the job was put into the shop. When the heat treatment developed for the experimental parts failed to hold for the production run, the result was so discouraging that beryllium-copper was thrown out of the design in many instances. A little better understanding of the importance of using a higher temperature and finding the right heat treatment for each lot would have eliminated this source of trouble.

Distortion or warping during heat treatment was, and is, another common problem. Any good heat treater knows that distortion in the hardening of steel parts is often caused by too high a temperature, so the natural thing to do when beryllium-copper parts distorted during hardening was to try

a lower temperature next time; and sure enough, distortion was reduced. Still lower temperatures gave still better results, until the least distortion was obtained with no heat treatment at all. Without heat treatment of course, beryllium-copper has no important advantage over phosphor bronze. But in a surprising number of instances beryllium-copper springs have been used without heat treatment just for this reason.

At the high-temperature, minimum drift heat treatment, distortion if uncontrolled would be a serious problem. But it can be turned into a real advantage if the parts are held in a jig or fixture during hardening. With a long-time, low temperature heat treatment, the cost of holding fixtures is a serious problem. At the short times required for a minimum drift heat treatment, however, high production can be maintained with only a relatively small outlay for fixtures.

Extreme distortion will occasionally take place even with fixtures. This usually occurs with material that does not come up to full hardness or tensile strength. This difficulty apparently results from mill operations that cause a non-uniform distribution of beryllium within the grain structure of the metal.[9] Segregation may take the form of beta phase stringers, or excessive precipitate at the grain boundary, both of which reduce the amount of beryllium available for hardening within the mass of the grain. The expansion taking place when the gamma phase precipitates, if localized through segregation of the beryllium, might be expected to cause distortion.

Perhaps by now this article has seemed to set up some serious limitations on the use of beryllium-copper. This need not be so. The equipment and test routine for measuring drift is fully developed and available. The procedure has in fact been "reduced to practice" and put into operation.

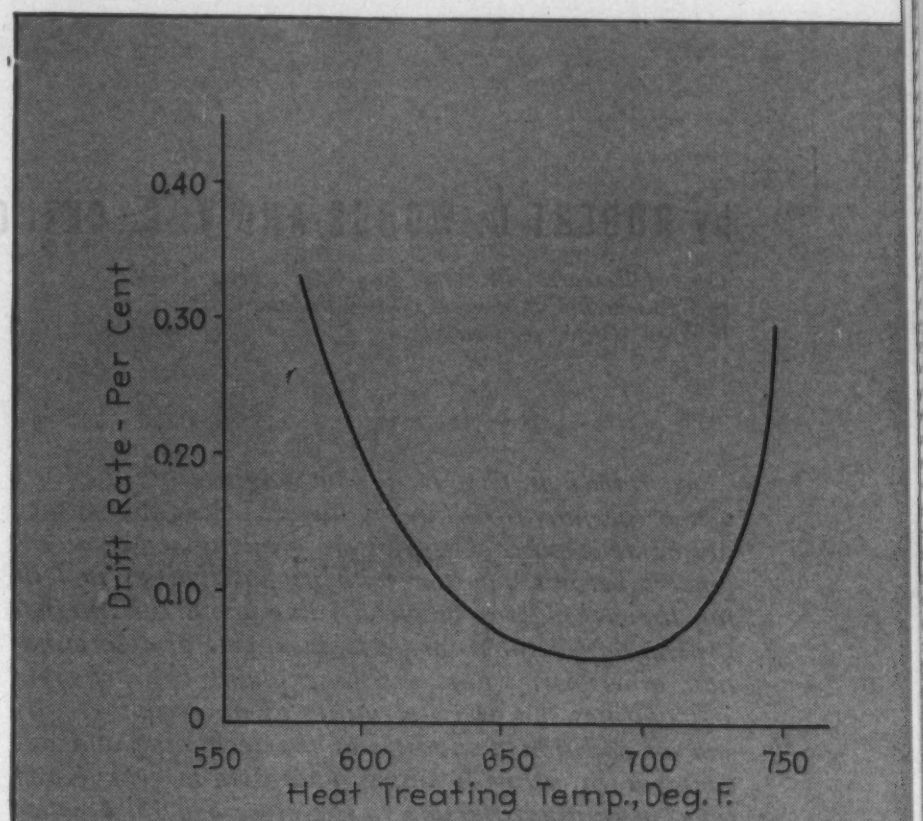
This practice requires the testing of incoming material for heat treatment response, a procedure which also gives a rapid and accurate method for determining the quality of the material before putting it into production. With final heat treatment of completed parts adjusted to the needs of each lot of material, uniformity in spring performance is readily obtained. With the short-time heat-treating cycle, fixtures can be used economically when desired to obtain much closer tolerances in final dimensions than are possible with other spring alloys.

And finally, good beryllium-copper material, heat treated for minimum drift, does closely approach the "wonder metal" it was originally expected to be.

References

[1] *Metllurgist* (London) Vol. 4, Sept. 1928, page 189.
[2] "Beryllium-Copper Alloys," by W. H. Bassett, *Proc.* Institute of Metals Div., AIME, Vol. 75A, 1927, pages 218-232.
[3] "Copper Beryllium Bronzes," by J. K. Smith, *Proc.* Institute of Metals Div., AIME, Vol. 99, 1932, pages 65-77.
[4] ASTM Standard B-120-41T.
[5] "Fatigue Properties of Non-Ferrous Sheet Metals," by C. H. Greenall and G. R. Gohn, *Proc.* ASTM, Vol. 37, Part II, 1937, page 160.
[6] "Measuring Elastic Drift," by R. W. Carson, *Proc.* ASTM, Vol. 37, Part II, 1937, pages 661-673.
[7] Patent No. 2,294,831.
[8] "Quality Inspection of Beryllium-Copper," by Wayne E. Martin, METALS AND ALLOYS, June 1943, pages 1203-1207.
[9] "Predicting Performance by Beryllium-Copper Wire and Strip for Springs," by H. G. Williams, *The Iron Age*, July 8, 1943, pages 62-67.

Fig. 2. The temperature selected for the hardening heat treatment for beryllium-copper has a large effect on the drift performance. Since each lot of material varies in its drift performance, the best temperature must be established by test.



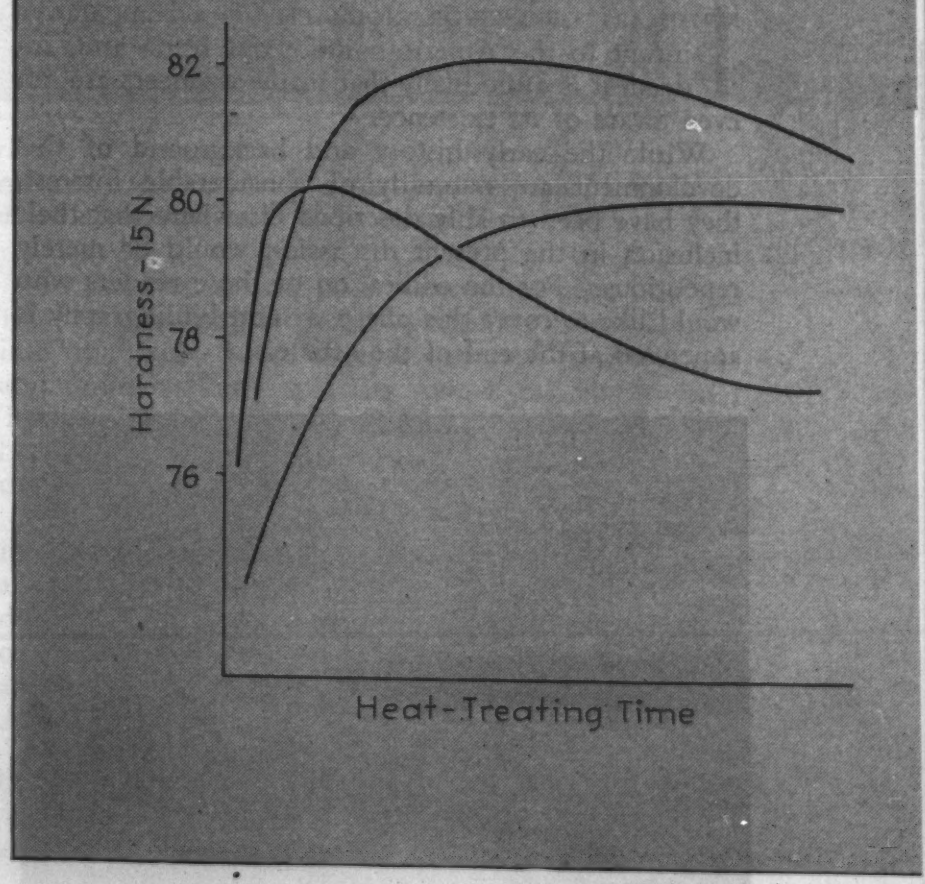


Fig. 3. Typical hardness-response curves for different lots of commercial beryllium-copper spring material. No single heat-treating time and temperature can be used to obtain satisfactory final properties for all lots.

Microradiography of Alloys

— A New Industrial Tool

by ROBERT C. WOODS AND V. C. CETRONE

Dir. of Research, Picker X-Ray Corp., New York, and Research Engineer, Taylor-Winfield Corp., Warren, Ohio, respectively.

Microradiography is a new engineering tool by which the microstructure of metals below the surface *can be determined. Its uses are growing as fast as engineers become familiar with its possibilities in telling them things of practical value about the internal structure of materials or parts, incapable of determination otherwise. This article explains the principle and outlines the practical utility of microradiography and in addition demonstrates the technique and advantages in using a* single *(tungsten-target) X-ray tube, in contradistinction to the more general practice of using several tubes for various alloys.*

—The Editors.

THE ART OF MICRORADIOGRAPHY is a comparative infant to the American industrial scene and, indeed, it is quite likely that many engineers are not even aware of its existence.

While the early history and background of this development are naturally of considerable interest, they have been so ably described elsewhere that their inclusion in the present discussion would be merely repetitious. For the edification of those readers who would like to cover this phase, a short bibliography is appended at the end of the article.

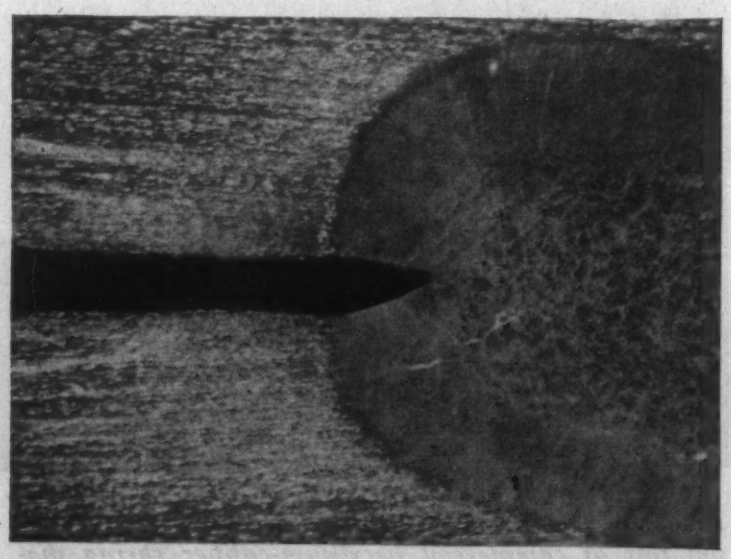


Fig. 1. Microradiograph of a cross-sectioned spot weld in 24ST alclad aluminum made with a tungsten target tube operated at 15 kv. Magnification 50X.

What Microradiography Can Do

When compared to many techniques now in vogue for the study of metal structure, microradiography is not at all a complicated one. Briefly, a properly prepared specimen of the metal or alloy in question is radiographed on an extremely fine-grained photographic film and the resultant image is then enlarged to whatever magnification seems desirable. Data obtainable by this technique are just about what one should logically expect from a consideration of the alloy structure radiographed, the X-ray absorption coefficients of metallic constituents involved, and the degree of magnification used. In other words, there is little of the mysterious about microradiography and no reason why the advisability of its application in any particular instance cannot be predicted. It is in the case of an unknown metallurgical factor—or a suspected unknown— that the method proves its greatest usefulness.

At this point, a pictorial example may be given and certain interpretations made, even though an explanation as to mechanics of the process is yet to come. Fig. 1 is a microradiograph of a spot-welded joint in two sheets of 24 ST alclad aluminum alloy. While the illustration appears almost identical to the usual photomicrograph of a sectioned spot weld, it is actually the radiographic record—enlarged to 50X—of a weld segment cut and X-rayed perpendicular to the plane of the sheets. This 24 ST alclad consists of a base sheet of aluminum alloy containing 4.5 Cu, 0.6 Mn, and 1.5 per cent Mg. As a corrosion protective coating, both faces of the sheet are covered with a thin layer of aluminum, pure except for traces of iron and other elements.

The view in Fig. 1, unlike a photomicrograph, does not merely look at a single surface, but really records obstacles encountered by the X-ray as it traverses a measurable thickness of material. Therefore, effects produced by internal chemical and structural irregularities will be radiographically enhanced by a piling up of these conditions between top and bottom of the specimen. This is in contradistinction to photomicrographic processes which are concerned only with two dimensional aspects and yield no information as to conditions existing below the immediate surface.

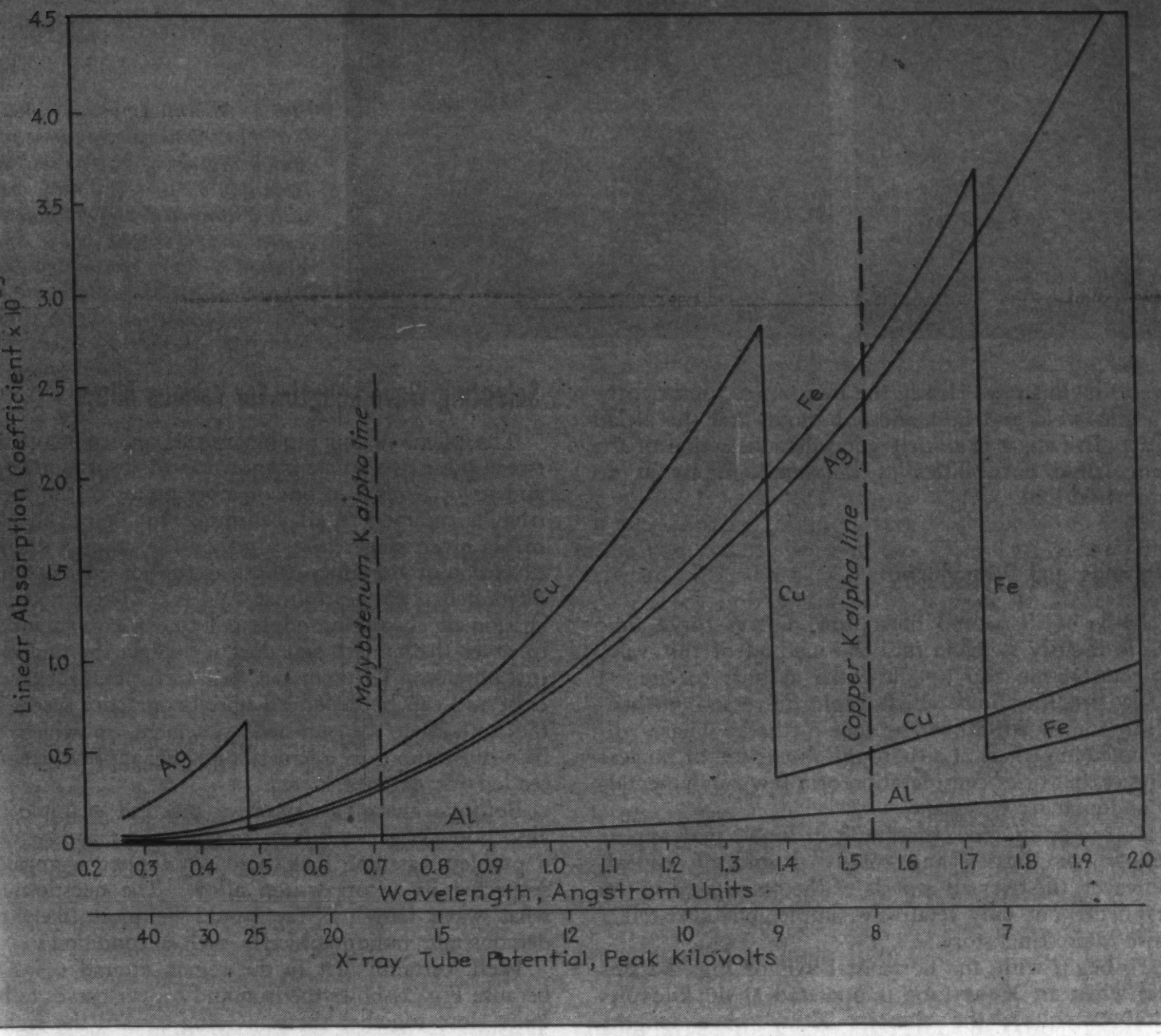


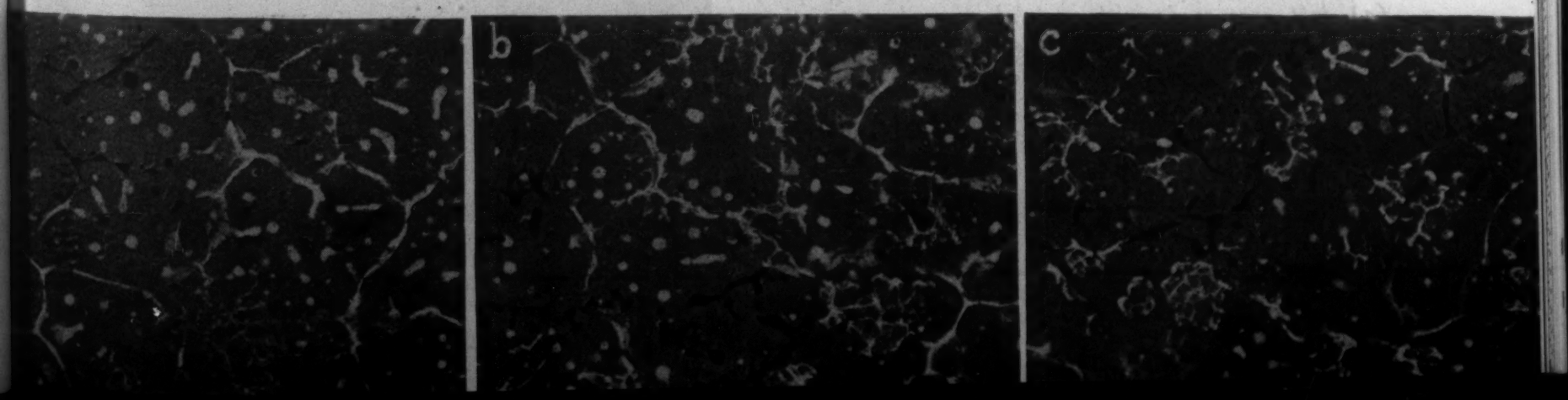
Fig. 2. Graph showing the X-ray absorption characteristics of a number of common elements. The two vertical dashed lines at 0.708 and 1.54 A show the location of the intense K alpha lines emitted by molybdenum and copper targets when operated at or above 20 and 9 kv. respectively.

This can best be illustrated by reference again to Fig. 1, where the 24 ST base metal appears as a dull gray background nearly hidden by white flecked, broken lines with a singular directionality. These myriads of white flecks represent the copper-bearing compounds of the alloy and reveal themselves here because of their higher X-ray absorbing property as compared to the surrounding aluminum areas. Under microscopic examination, the copper segregates also appear, but far more dispersed than in Fig. 1, since only the surface is being viewed, whereas in the microradiograph all copper particles in a relatively thick sample are being heaped one upon the other. Thus, the situation is accentuated but not exaggerated.

To point out a few other interesting facts in Fig. 1, the black, elongated zone—extending from the left into the welded area—represents the nearly pure aluminum cladding with its low X-ray absorption. That the cladding is not wholly pure is demonstrated by the tiny white specks here and there. Microscopically these prove to be specks of iron impurity.

Noticeably heavier concentrations of white material in the base metal above and below the alclad dagger are caused by copper-aluminum eutectic streamers produced during the process of spot welding. Existence of still greater deposits of copper-aluminum eutectic appear in the weld itself as jagged white strokes. Although this picture shows only about half a spot

Fig. 3. Microradiographs at 100X of sand cast No. 195 aluminum alloy containing 4 per cent Cu. Radiograph (a), left, was made using a molybdenum target operated at 40 kv; (b), center, is the results obtained with a tungsten target at 15 kv, and (c) right, was made with a copper target at 30 kv.



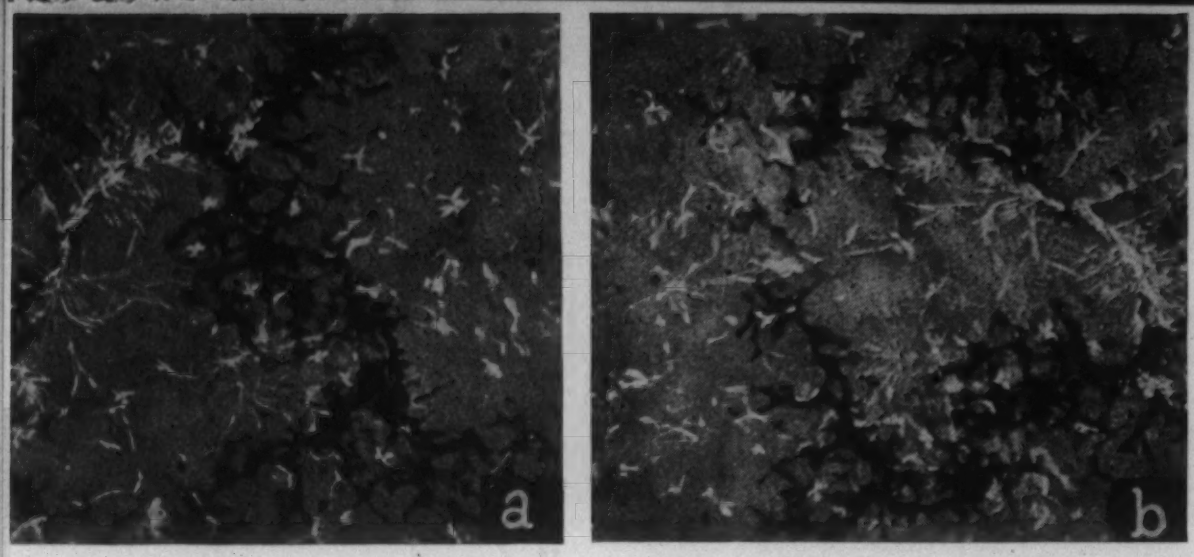


Fig. 4. Microradiograph of sand cast No. 220 aluminum alloy containing iron impurities. Radiograph (a), left, was made with a tungsten target tube operated at 15 kv, while (b), right, resulted from exposure with a copper target tube at 30 kv. Magnification 100X.

weld, it illustrates clearly the cast nugget outline, the various weld and heat affected zones, and the alclad seal. In fact, it is a fairly good demonstration of the remarkable possibilities of microradiography as an industrial tool.

Methods and Procedures

Paths of discussion must now digress for a time while inquiry is made into the method of this valuable technique and to allow the authors to suggest a few simplifications which might decrease both handling and expense over present methods. There will be no attempt here at a thorough discussion of nuclear physics, but brief consideration of a few fundamentals is undoubtedly necessary.

To the uninitiated, the graph in Fig. 2 may appear unduly complicated and totally devoid of appeal. However, the over all aspects of the case stated in the graph are not only relatively simple, but also tell a most interesting story.

To begin with, the horizontal axis of Fig. 2 states that when an X-ray tube is operated at 40 kilovolts (40,000 volts), the shortest X-ray wave lengths emitted by the tube will measure 0.31 A° from crest to crest. Or if the tube is operated at 15 kilovolts, the shortest emitted wave will be 0.82 A°, or at 10 kilovolts it will be 1.23 A°, and so on.

This does not mean that a tube operated at 40 kilovolts will emit only 0.31 A° X-rays. There will also be plenty of other wave lengths present, but they will all be of wave lengths longer than 0.31 A°.

Another fact that Fig. 2 yields is the general observation that the absorption characteristics of any single element not only differ from those of other elements, but also vary with the wave length of X-radiation involved. Thus, using numbers on the graph, the absorbing power of copper to X-rays of 1.5 A° is 0.4, but a decrease of X-ray wave length by only 0.2 A° raises copper absorption to 2.5. Actually, due to the exponential nature of X-ray absorption coefficients, the real difference in absorption is tremendously greater than just the ratio of the two numbers.

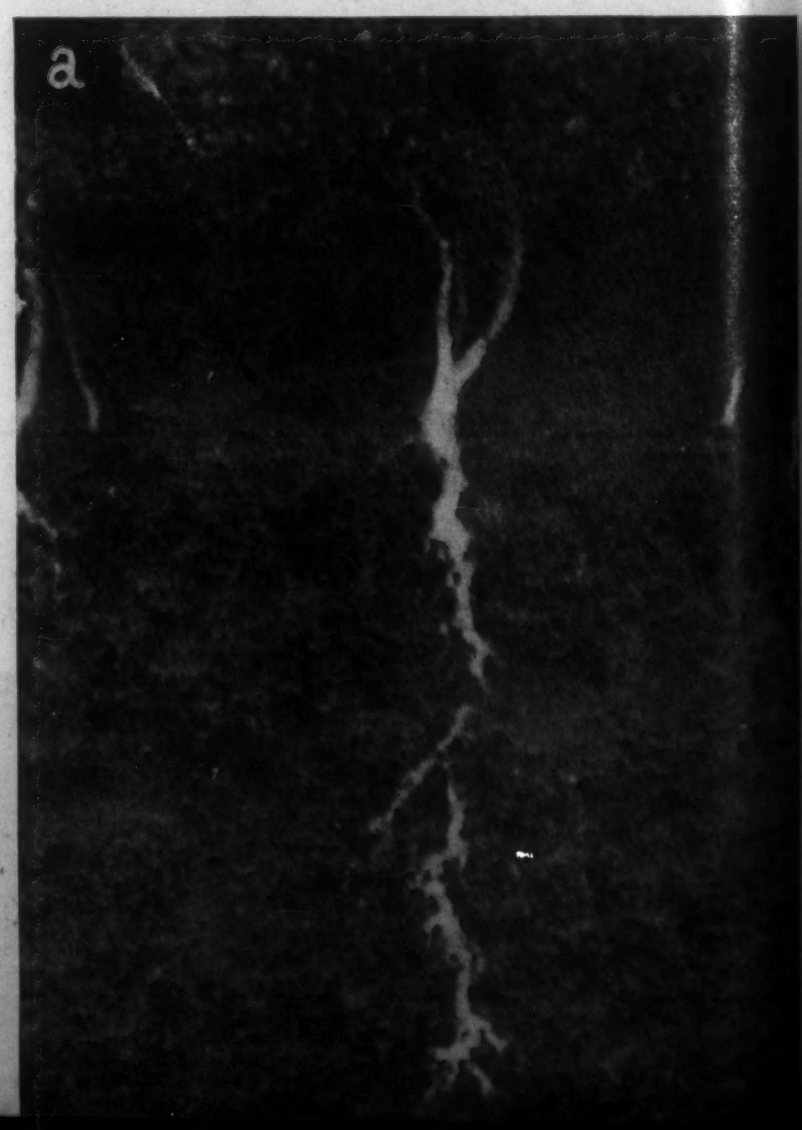
Fig. 5. Microradiographs of a fused area in a single sheet of 17 S aluminum. The prominent white streamers are due to copper-aluminum eutectic. Radiograph (a), left, was made with molybdenum characteristic radiation, the tube being operated at 40 kv. The superiority of 15 kv tungsten radiation in this instance is shown in (b), center, while (c), right shows results obtained by using characteristic copper radiation, the tube being operated at 30 kv. Magnification 100X.

Selecting Wave Lengths for Various Alloys

The phenomenon producing the sudden jump between these two points is known as an absorption edge and its occurrence at one or more points of the spectrum is common to all elements. In Fig. 2, all elements given show these edges on the graph with the exception of aluminum whose absorption edge is quite off the chart to the right at 7.94 A°. This brief discussion of absorption edges is by no means intended to cover the subject, nor does it explain the underlying physics. To point out that such phenomena do exist and can be depended upon in practice seems to the authors to be sufficient statement on which to base illustrations of microradiographic applications intended for engineers.

Before leaving this phase, a practical example of absorption edge usefulness might not be amiss. As a problem, assume that there are copper segregates suspected in a copper-iron alloy. The question is, what wave length X-ray would be most likely to demonstrate radiographically such a condition?

Well, certainly not in the region around 0.3 A°, because Fig. 2 shows the iron and copper curves to be quite close together there. Going toward the right-hand side of the graph, around 2.0 A°, the situation improves, but the ideal condition has not yet been realized; namely, the greatest possible spread between



the two absorption values. Just to the left of this region, an iron absorption edge springs to a summit of 3.5, still leaving copper below it in the valley at slightly over 0.5. It is clear, then, that the most favorable contrast between copper and iron is obtained using a wave length somewhere between about 1.37 A° and 1.73 A°. This represents the optimum, an optimum unfortunately rarely attained in practice. Nevertheless, the principle is there and it will later be seen how good a use can be made of it.

A point must now be considered which is somewhat of a corollary of the foregoing condition and based on the same general principle. Just as each element has its X-ray absorption edge, so it also has its X-ray emission edge. Stated simply, this means that X-ray emission from a tube, using any given element as target, consists of many different intensities associated with many different wave lengths. But if the exciting voltage is up to, or beyond, a certain well defined limit, a wave length characteristic of the target material will predominate all others in intensity. Below this well defined voltage limit, this line does not appear. Above the limit, the intensity output of the characteristic line climbs very fast, far more rapidly than that of other wave lengths present. The wave length of this intense line is always slightly greater than the wave length of the absorption edge of the element producing the line. This line is generally referred to as the K alpha emission line, because it is the result of intra-atomic disturbance in the K electron level.

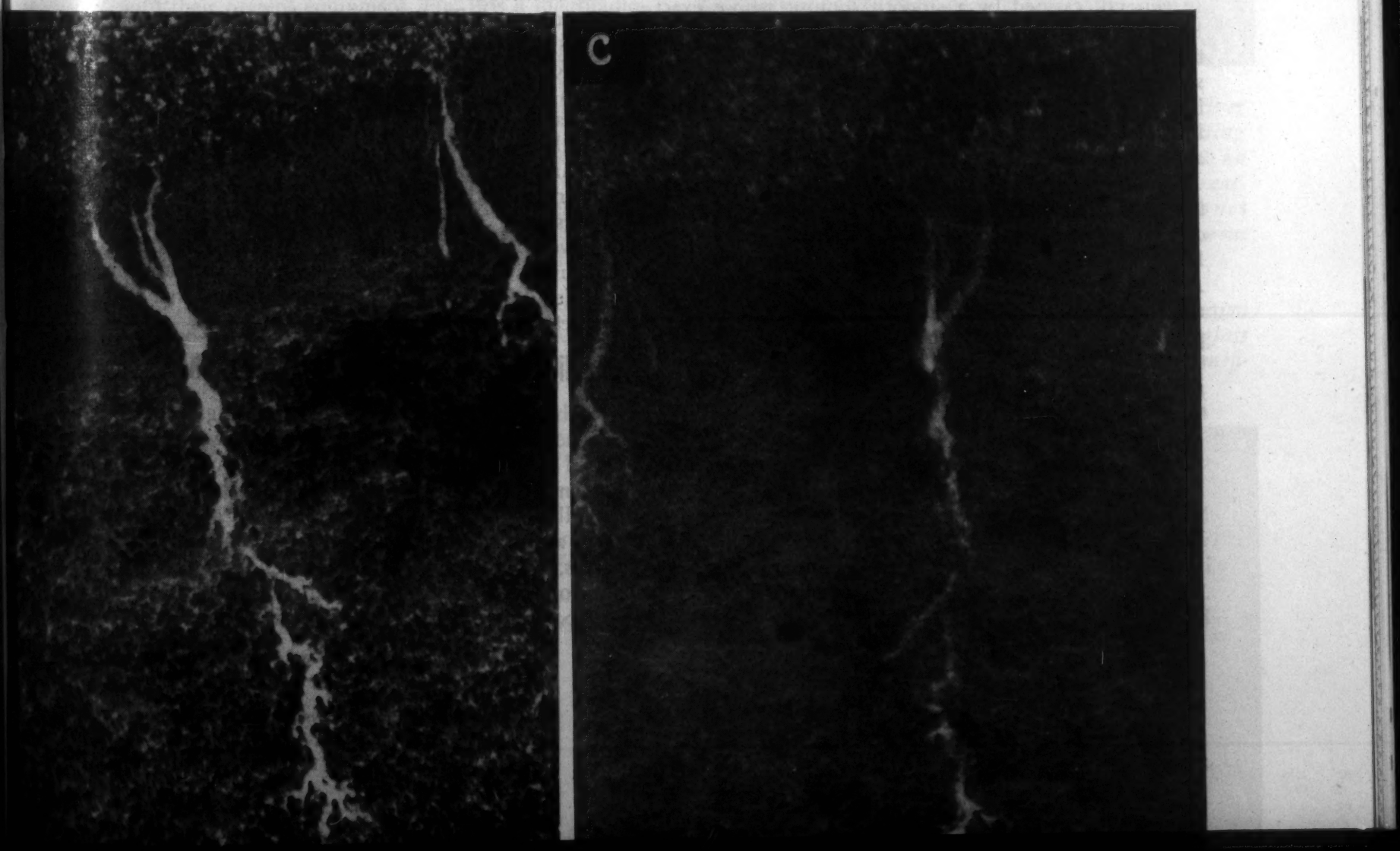
To be more explicit, when an X-ray tube with copper target is being operated at 7 kilovolts, the beam emitted is composed of 1.76 A° X-rays and longer (see Fig. 2). As the voltage is raised, however, a point at about 9 kilovolts will be reached at which the strong copper K alpha line will appear—at 1.54 A°—in conjunction naturally with the other longer wave lengths also being produced. If the voltage is now raised to 40 kilovolts, shorter wave lengths all the way up to 0.31 A° will join the procession, but the intensity of the characteristic copper line will outshine any one other wave length. A similar phenomenon occurs with X-ray tube targets of iron, or molybdenum, or silver, although the K line of each substance comes off at a different location. This, in its most abridged form, is the principle of element spectral emission and only an operational description is attempted here, not a fundamental explanation.

It must now be evident how spectral emission ties in with absorption edges. A point was previously brought out that the most favorable radiation in the case of a hypothetical copper-iron alloy would be produced by a tube emitting X-rays of wave lengths between 1.37 A° and 1.73 A°. But above, it was shown that at 9 kilovolts, a copper target tube began to produce a very intense beam in this desired wave length range, and that as the voltage was further raised, the same copper line continues to increase in strength. This, then, would seem to be the answer to the problem.

Out of this sound theory, quite a vogue has been developed throughout the country to operate iron, cobalt, copper, molybdenum, etc., diffraction tubes all at 30 to 40 kilovolts to obtain intense X-ray lines as desired in the regions of 1.9 A°, 1.8 A°, 1.5 A°, 0.7 A°, etc., respectively. The ordinary garden variety tungsten target tube was considered unsuitable, because its strong K line does not even begin until the exciting voltage reaches about 68 kilovolts.

Advantages of a Single Tube

Despite the evidence in favor of using a series of various targets for microradiography of various alloys, there is one great disadvantage. These different tubes cost about $300 each, so that even a modest assortment of five tubes is an item of expense, aside



from cost of the generating unit. Moreover, the work involved in changing tubes every time a different alloy is to be radiographed does not exactly lend itself to mass production. In short, it would certainly be a saving in time and money if one tube could be used for microradiography of all specimens.

Accordingly, the authors undertook a series of practical experiments to determine how much to-the-eye advantage is gained by target juggling to obtain strong K emission lines, as against a tungsten target operated to yield its peak emission in various desired wave length ranges. For this purpose, there were three X-ray tubes available having targets of copper, molybdenum, and tungsten. All were fitted with low-filtration windows of thin beryllium and were identically constructed by the Machlett Laboratories, Inc. A simple, light-tight box held both specimen and photographic film in intimate contact. The film used in all cases was Eastman spectrographic, Emulsion No. 548-0 and the specimens were ground to a thickness of the order of 0.003 in. Some polishing was done on the samples, but the job was by no means a metallographically perfect one. The resulting films were enlarged on the metalloscope to the diameters indicated on the illustrations.

The first specimen, Fig. 3, is a section of an aluminum sand-cast alloy, designated by the Aluminum Co. of America as alloy No. 195, containing 4 per cent Cu. The irregular white lines are copper-aluminum eutectic, which join at the grain boundaries, while black areas are undoubtedly voids. The matrix is aluminum-rich solid solution. Reading from left to right, these radiographs were made with a molybdenum target operated at 40 kilovolts (a), with a tungsten target at 15 kilovolts (b), and with a copper target at 30 kilovolts (c). Thus, both copper and molybdenum targets were emitting their intense individual K lines, since voltages required to produce these are 9 kilovolts and 20 kilovolts respectively. However, emission from the tungsten target was mostly general, capped by a smooth summit whose exact location in this case is unknown. But even so, the tungsten peak intensity will not compare with the strengths of copper or molybdenum peaks, although both the latter targets are producing some wave lengths shorter than any emitted from the tungsten at low voltage.

Reference again to Fig. 2 would seem to indicate that the radiation most suited for demonstration of copper and aluminum absorption differences would lie in the 1.5 A° range, or equally as well in the 0.7 A° range; that is, in the regions of the copper or molybdenum K alpha lines. While the specimen areas pictured in Fig. 3 are not all identical, it is evident that a tungsten target at 15 kilovolts does as good a job as the copper target at 30 kilovolts, and it certainly seems better than molybdenum at 40 kilovolts.

The second specimen, Fig. 4, is a section of another sand-cast aluminum alloy No. 220, which contains 10 per cent Mg, with probable iron impurities. Magnesium and aluminum absorption coefficients are very close together, so consequently there is little hope of differentiating one from the other. But Fig. 2 indicates that to reveal iron impurities in this alloy, K radiation of about 1.5 A° should be preferable to

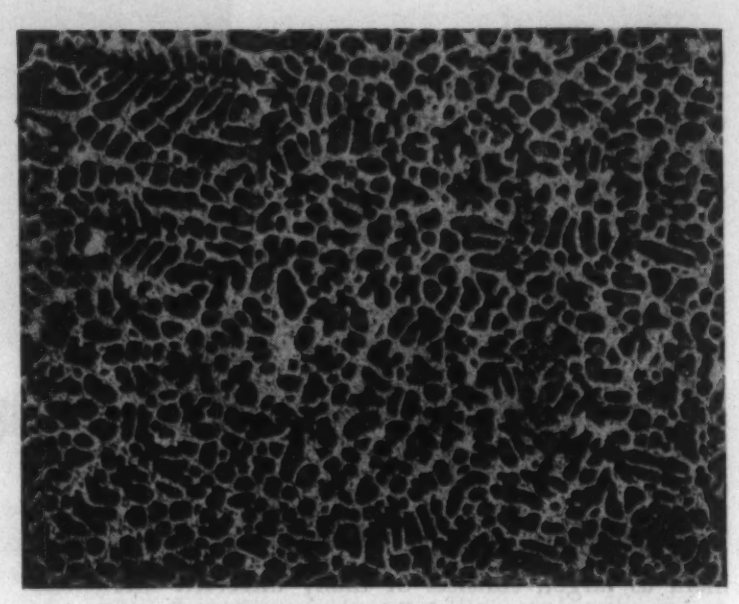


Fig. 6. Conventional photomicrograph of an alloy of 65 per cent Cu and 35 per cent Ag. Dark areas are copper-rich dendrites, while the light inter-dendritic areas represent silver-rich eutectic. Magnification 70X.

any other. In Fig. 4, radiograph (a) is taken with a tungsten target tube at 15 kilovolts, whereas (b) is made with a copper target tube at 30 kilovolts. Certainly the needle-like iron impurities stand out no whiter in (b) than in (a)—nor do the black void areas.

A further instance of these comparative tests is seen in Fig. 5. The specimen used is a sectioned fused area in a single sheet of 17S aluminum alloy with its 4 Cu, 0.5 Mn, and 0.5 per cent Mg. Such a fused slug was formed by bringing the tips of a spot welding machine together on a single sheet and then passing a heavy condenser-discharge current. The resulting structural zones are similar to those of an ordinary spot welded joint and in (a), (b), and (c) of Fig. 5 they are—from top to bottom—the equiaxed zone of the cast nugget, the columnar zone of the nugget, and parent metal. The white irregular stringers are segregates of copper-aluminum eutectic.

Now, from consideration of the graph, it would seem that a radiograph made with molybdenum K alpha radiation or with copper K alpha radiation should definitely give the best results, yet it does not apparently work out that way. Radiograph (a) was made with molybdenum at 40 kilovolts, (b) with tungsten at 15 kilovolts, and (c) with copper at 30 kilovolts. There is little doubt that the tungsten picture is superior to the others in contrast and overall detail. And, in fact, the radiograph with a copper target is certainly second-rate.

Applications of the Tungsten-Target Tube

Above all, the authors wish to bring out the extreme flexibility of the tungsten target when it is desired to select radiographically the various constituents of an alloy. To illustrate this point, the authors cast an alloy composed of 65 Cu and 35 per cent Ag. Fig. 6 is a photomicrograph of the resultant alloy. Dark areas, which solidified first on cooling, are dendrites of copper-silver solid solution, rich in copper—over 90 per cent. Light inter-dendritic filling is the low

melting point silver-copper eutectic, composed of an intimate mixture of silver-rich solid solution and copper-rich solid solution. The composition of this eutectic is 70 Ag and 30 per cent Cu.

Fig. 2 discloses that at the extreme right—at voltages below 9 kilovolts—silver absorption is high and copper is low. Fig. 7 (a) is a radiograph of the copper-silver alloy with a tungsten target operated at 8 kilovolts. Notice that the dark, penetrated areas represent copper-rich solid solution dendrites, while the white, highly absorbing zones are silver-rich eutectic.

Now in Fig. 7 (b) the situation is reversed. Tube voltage has been raised to 24 kilovolts and a wave length region is entered where the absorption edge of copper has brought it well above silver in the graph. Here the light areas are copper-rich (instead of silver-rich) solid solution and dark sections are silver-rich eutectic.

Toward the lefthand of Fig. 2 chart, it will be noted that at 25 kilovolts silver experiences its K absorption edge and bounds up above copper. Fig. 7 (c) illustrates this phenomenon radiographically, for the tungsten tube was here operated at 40 kilovolts and the constituents behave toward the X-ray beam much as in the first picture, Fig. 7 (a).

In view of these results—and others as satisfactory—it is difficult to see how the expense and labor associated with what might be termed multiple tube microradiography is warranted. In theory, the use of various targets appears justified, but in application this justification seems to evaporate. Such a situation may arise from insufficient data on the actual spectral emission of different tubes. It could be, for example, that while a copper target undoubtedly produces an extremely intense beam of its own K alpha radiation, yet the *total intensity* of other less-desirable wave lengths simultaneously emitted at higher voltages is enough to offset the advantage.

For the benefit of those who wish to experiment with their present equipment, Fig. 8 is a microradiograph of the same subject appearing in Fig. 3, made with an ordinary glass window type tungsten target tube such as is routinely used for inspection of castings, forgings, weldments, and other industrial materials. While Fig. 8 is undeniably not as good as the radiograph made with the tungsten tube having a thin beryllium window, the information is all there. This illustrates the point that perhaps careful technique and wide selection of wave length emission are more to be desired than any number of different X-ray tubes.

In closing, the authors wish to acknowledge with gratitude the valuable suggestions, advice, and work of John C. Barrett, metallurgist of the Taylor-Winfield Corp.

Bibliography

H. S. Rawdon, "Microscopic Examination of Metals (By X-Rays)" *Chem. & Met. Eng.*, 1921, Vol. 24.

Harold F. Sherwood, "The Radiography of Small Biological Specimens." *Radiography and Clinical Photography.* Eastman Kodak Co., 1934.

O. E. Schupp and E. R. Boller, *Ind. Eng. Chem.*, 1938, Vol. 30.

G. L. Clark and W. M. Shafer, *Trans. Amer. Soc. Metals*, 1941, Vol. 13.

Harold F. Sherwood, "Radiography of Cultured and Natural Pearls," *Photo-Technique*, March 1941.

G. L. Clark and S. T. Gross, *Ind. Eng. Chem.*, 1942, Vol. 14.

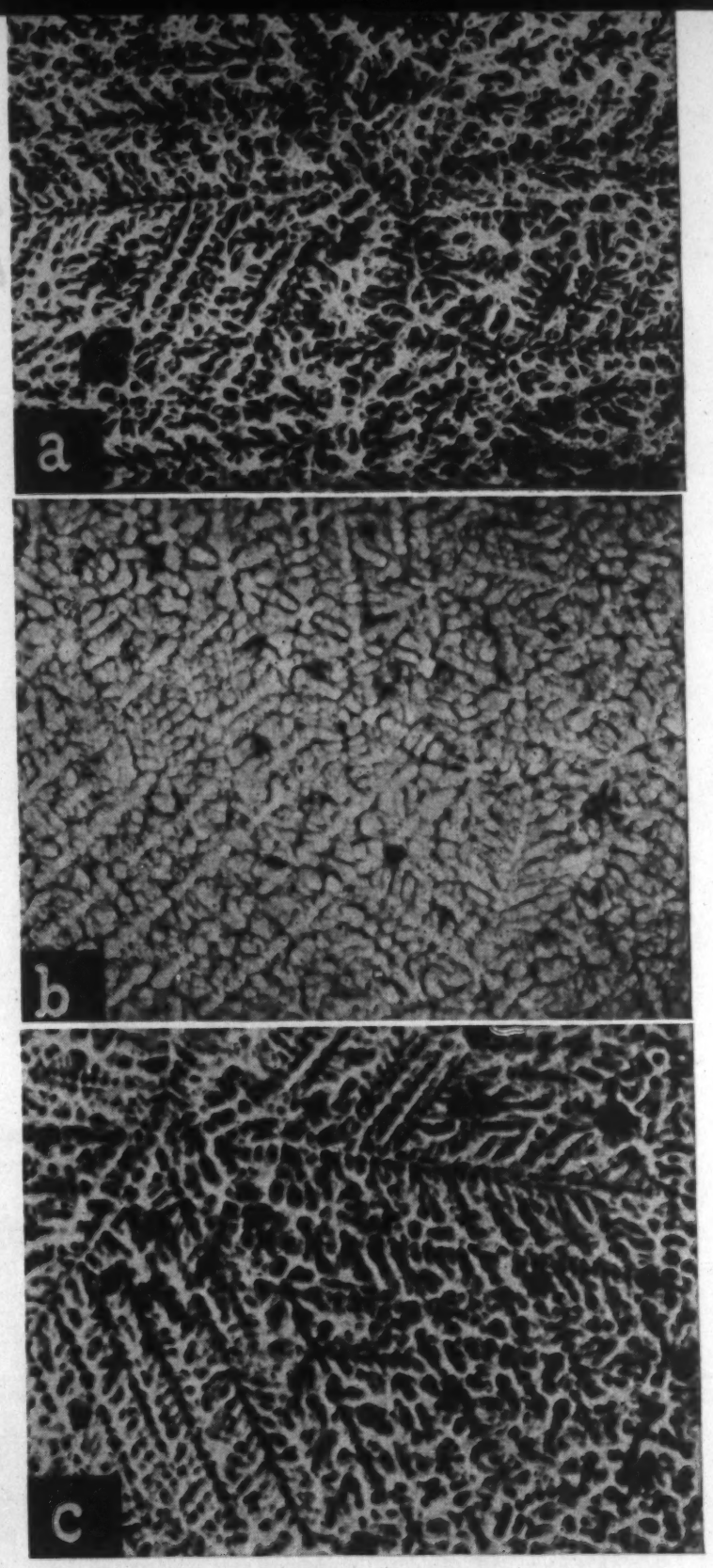
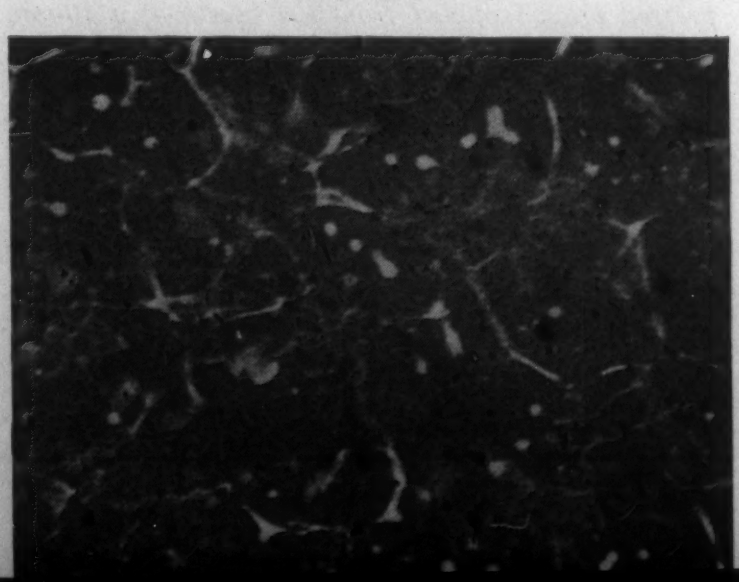


Fig. 7. Microradiographs at 70X of the copper-silver alloy shown in Fig. 6. All pictures were made using a tungsten tube. Radiograph (a), top, made at 8 kv shows the copper-rich dendrites as black. By increasing the voltage to 24 kv in (b), center, the dendrites become white, and at 40 kv again show as dark areas in (c), bottom.

Fig. 8. Microradiograph of the same alloy as shown in Fig. 3. This was made with an ordinary glass window type tungsten target tube at 15 kv. Magnification 100X.



Zircon Refractories for

Despite the relatively low melting temperatures developed in them, aluminum-melting furnaces present a sizeable refractories problem. Of special interest, therefore, is this report of operating experience in the use of zircon (zirconium silicate) refractories to improve not only hearth life and production rate, but also the quality of the metal melted. —The Editors

THE EXPANSION of the light metals industry during the past 3 yrs. has presented new refractory problems. If the refractories industry ever succeeded in developing a product which is unequalled, even uniquely fitted for a particular purpose, zircon is certainly that product when used for the construction of the working hearth in the reverberatory or open-hearth furnace employed for the melting, re-melting or alloying of aluminum.

HOT FACE OR HEARTH LEVEL

Fig. 1 (above) A section through a high heat duty firebrick removed from the hearth of a 10-ton, oil-fired aluminum remelting furnace. The original structure has been altered by the penetration of aluminum and thermit reaction with iron and silica.

HOT FACE OR HEARTH LEVEL

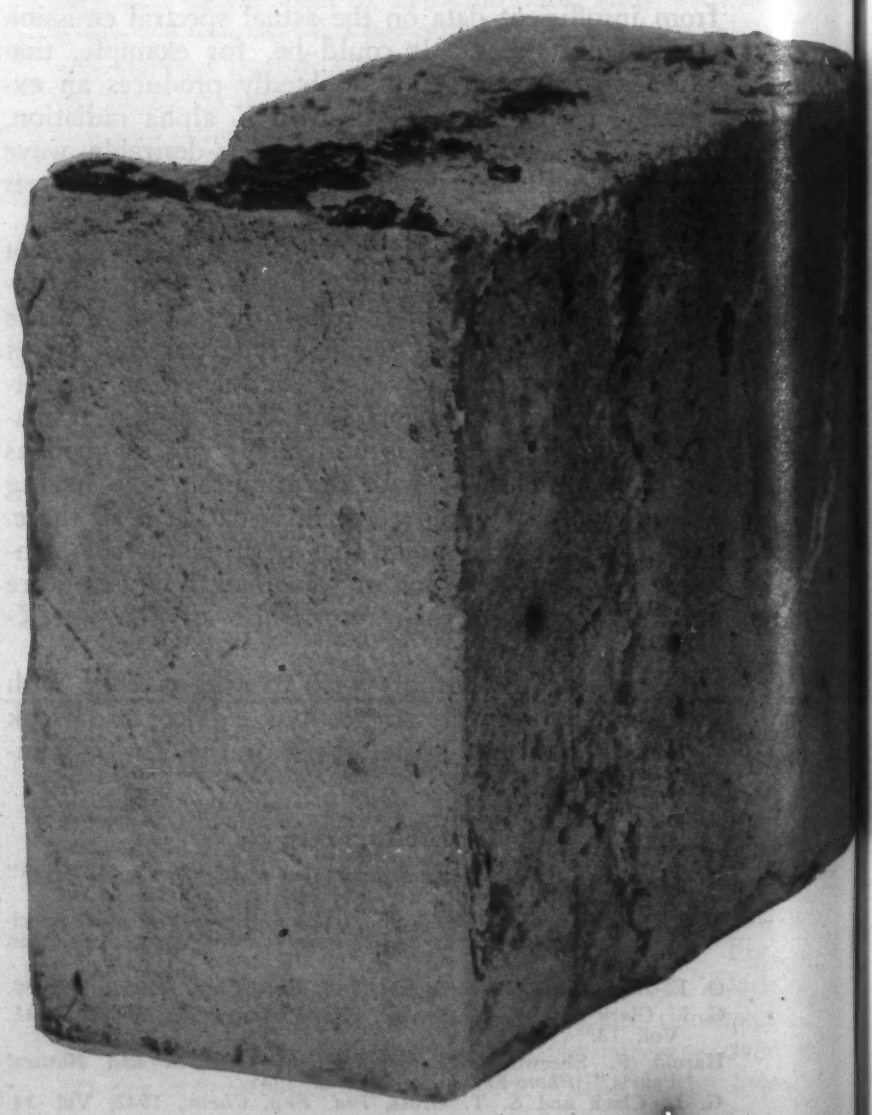


Fig. 2. (right) A section through a zircon power pressed brick removed from the hearth of a 10-ton, oil-fired aluminum remelt furnace. About 14,750,000 lbs. of aluminum scrap, foundry returns and chips were melted on this hearth in approximately 11 mos. There has been no penetration or evidence of thermit reaction — substantiated by petrographic analysis. Note how well the thin, dipped joint of zircon cement adheres to the brick and blocks penetration of the metal and dross through the joints.

Aluminum Melting Furnaces

by R. W. KNAUFT *The Chas. Taylor Sons Co. Cincinnati, Ohio.*

Fire Brick Hearths

The melting points of commercial aluminum and the common alloys are quite low—1216 to 1300 deg. F.—so furnace temperatures are within the safe operating limits of any approved first quality fire brick. High heat duty fire brick, super-duty and high alumina refractories fail, even at these low temperatures, by one or more of the following causes, effecting a gradual alteration in original structure: Penetration by metal, oxide or vapor; thermit reaction with iron oxides and silica; and mechanical abuse when charging and cleaning the hearth and side walls.

Fig. 1 is representative of what happens to a selected grade of high heat duty fire brick after continued service in a 10-ton, fuel fired aluminum remelting furnace. The brick was broken at the junction of the metamorphosed area and the unaltered fire brick when attempting to remove the entire brick from the hearth. A petrographic examination of a thin section taken from the metamorphosed area revealed the presence of a high percentage of well crystallized corundum with some opaque inclusions. Some of these inclusions are aluminum metal and the remainder are probably silicon or ferrosilicon. The large amount of corundum present is evidence of a thermit reaction between the clay and the aluminum. Schurecht (*Journal* of the American Ceramic Society, September, 1940) has noted an alumino-thermic reaction between fire clay and aluminum at temperatures between 800 and 950 deg. C. (1470 and 1740 deg. F.). Any oxides of iron present would accelerate the thermit reaction. The original structure of the fire brick has been destroyed within the pene-

Fig. 3. Condition of a zircon hearth in a 10-ton Dempsey remelt furnace after having produced nearly 14,000,000 lbs. of aluminum in about 10 mos. (Courtesy: Wright Aeronautical Corp.)

trated area, as substantiated by the following data:

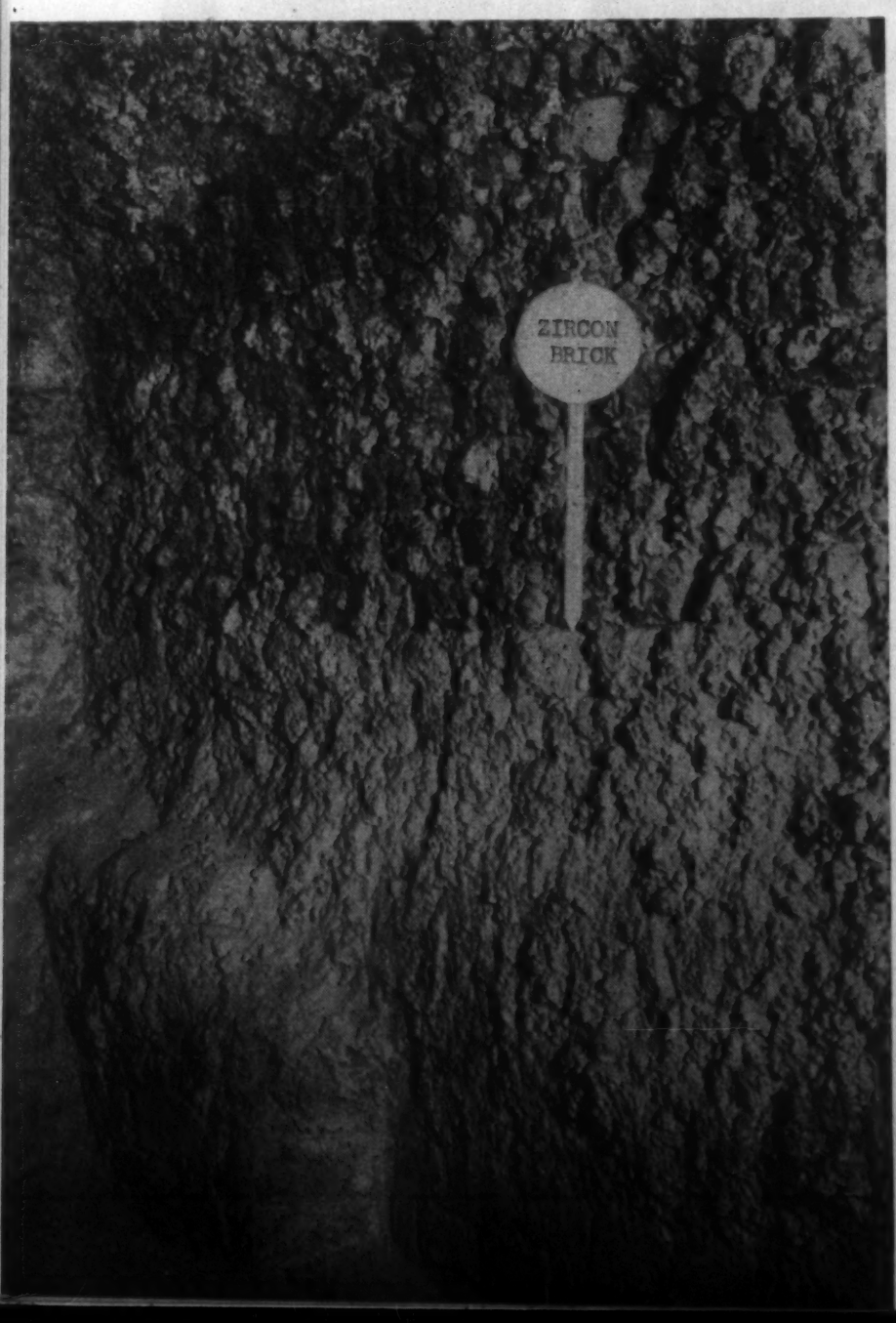
Brick	Weight per cu. ft., lbs.	Apparent porosity, per cent
Original fire brick	135	18.6
Fire brick after service (See Fig. 1)	204	1.7
Original zircon brick	215	22.3
Zircon after service (See Fig. 2)	213	23.7

Aluminum does not penetrate zircon refractories, as is shown in Fig. 2. Consequently, hearths built of this brick are easier to maintain and are a valuable aid in the increased production of cleaner metal. A zircon brick hearth can be cleaned in one-third to one-half the time required to clean a fire brick, super-duty or high alumina brick hearth—either hot or cold.

Burrows (*Journal* of the American Ceramic Society, May 1940) in his paper entitled "Effect of Molten Aluminum on Various Refractory Brick" includes the following statements:

> In melting aluminum in open-hearth furnaces, there is a tendency for aluminum oxide or dross to build up on the furnace walls and in the corners of the hearth. This aluminum oxide is soft and easily removed when it is first formed. If it is allowed to remain for any length of time, it gradually becomes harder, denser, more adherent and more difficult to remove and if the accumulation is not removed regularly it will gradually decrease the capacity of the furnace. To remove aluminum oxide or dross, the hearth and side walls must be scraped vigorously with iron bars and scrapers. This process sometimes removes the surface of the brick if the oxide has been allowed to accumulate too long.

Fig. 4. The hearth of the same furnace as in Fig. 3 after it had been cleaned. The side wall at the metal line has not been cleaned. (Courtesy: Wright Aeronautical Corp.)



Contaminated or penetrated hearths are a source of inclusions and dirty metal. Aluminum castings, ingots, billets for extrusion and forging of sheet bars can be "sabotaged" very effectively by inclusions of spalls or small particles of refractory. The specific gravity of fire clay brick is 2.6 to 2.65 which is about the same as that of molten aluminum (given as 2.7). Any bits or spalls of refractory which become dislodged from the masonry are apt to remain in suspension below the level of the bath. If the inclusion lies at the surface of the ingot or casting, the piece can be scrapped, involving only a loss in production, time and material up to that point. If the vitreous, fire brick inclusion is entrapped below the surface of the casting, billet or ingot, trouble may arise either when the piece is machined or when the part is in service. Cutting tools either break or may be badly chipped when they strike vitreous, refractory inclusions at high speed.

Refractory inclusions also damage extrusion dies and frequently are the source of "cat scratches" on the finished product. In the production of aluminum sheets and foil, clean metal is paramount as inclusions of vitreous material will puncture or mark the sheet and may do costly damage to the highly polished rolls.

Zircon Refractories

Zirconium silicate refractories, commonly referred to as zircon, have the peculiar property of not being readily "wet" by aluminum metal, dross or oxide. The apparent specific gravity is 4.46 so that spalls or small particles of zircon brick will not float in aluminum or the common alloys. These properties alone will save a lot of expense, time and trouble for the melter who selects zircon brick for the hearths of his aluminum melting, alloying or scrap remelting furnaces.

Experience gained over the past 2 yrs. has shown conclusively that hearths built of zircon brick, laid in zircon cement, offer these advantages over hearth constructed of either fire clay, super-duty, high alumina or silicon-carbide brick:

1—Cleaner metal.
2—Increased output per furnace through uninterrupted production.
3—Longer hearth life.
4—Lower hearth cost per ton of metal produced.
5—Versatility—such hearths are unaffected by either oxidizing or reducing atmosphere.

The condition of a zircon hearth in a 10-ton Dempsey re-melt furnace after having produced 13,800,000 lbs. of aluminum in approximately 10 months is shown in Fig. 3. The furnace melts an average of 50,000 lbs. of scrap, foundry returns and chips every 24 hrs. These pictures were taken when the unit was

Fig. 5. The dross and partially oxidized metal can be easily separated from the zircon hearth. The side wall has been cleaned. (Courtesy: Wright Aeronautical Corp.)

shut down after a 30-days run, for cold cleaning. The hearth was scraped "hot" when the last heat was tapped on the previous night. There are no heavy accumulations of dross adhering to the zircon hearth and side walls. All metal was cast as ingot.

The same furnace as in Fig. 3 after the hearth had been cleaned is shown in Fig. 4. The zircon side walls have not been cleaned, except for the shoveling away of the loose dross on the hearth. Some of the dross has been knocked off the fire brick upper-structure, taking chunks of brick with it. This exposes new surfaces and greater area to further attack. Note the smooth, clean outline of zircon brick in the hearth and at the base of the side wall.

The ease with which dross and partially oxidized metal can be separated from the zircon hearth is revealed in Fig. 5. The zircon brick in the side wall have also been cleaned. The rough surface adjacent to the metal line is opposite the charging door. The scrap is thrown against the back wall when the furnace is charged. The furnace is hand charged, the average weight of scrap charged being 83 lbs. It is advisable to leave a shallow pool of metal on the hearth when charging to protect the brick against

abrasion. The average life of fire brick hearths in this plant was 10 to 12 weeks, with frequent shut downs for cleaning and repair.

Fig. 6 is an un-retouched photograph of the slabs of dross removed in Fig. 5. The aluminum has not penetrated the zircon brick and the outline of the joints between the brick are clearly defined. There was no leakage of metal through the tight joints protected with zircon air-setting cement.

The properties of zircon brick are presented in an accompanying table.

The average chemical analysis of zircon brick is as follows:

	Per Cent		Per Cent
ZrO_2	—64.71	Fe_2O_3	—0.15
SiO_2	—34.80	CaO	—0.02
Al_2O_3	—0.02	MgO	—0.02
TiO_2	—0.06	Alkalies	—0.01

Zircon refractories must be made of the purest grades of zirconium-silicate ($ZrSiO_4$) if the best results are to be obtained in service. The brick should not contain clay or similar bonding ingredients which might re-act with the zircon to lower the softening point and tend to destroy the non-wetting property, with respect to aluminum dross. Zircon brick hearths should be laid with thin, dipped joints of a clayless, smooth working zircon cement—one that will prevent penetration of metal and dross through the joints.

The author is indebted to the Wright Aeronautical Corp., and the foundry personnel in particular, whose co-operation made it possible to accumulate and record many of these data. The work published by H. O. Burrows and H. G. Schurecht, in the *Journal* of the American Ceramic Society, was also an aid in correlating results obtained from field installations of high heat duty fire clay brick and other aluminum-silicate refractories.

Properties of Zircon Brick

Apparent specific gravity	4.46
Aver. weight of 9 x 4½ x 2½ brick	12 lbs.
P.C.E. of softening point	Above Cone 42 (2015 deg. C. or 3660 deg.)
Load test deformation—(1350 deg. C. or 2460 deg. F. at 25 p.s.i.)	None
Modulus of rupture	1075 lbs. per sq. in.
Cold crushing strength (An average crushing strength for stiff-mud firebrick is 3000 to 4000 p.s.i.)	7045 lbs. per sq. in.
Linear co-efficient of expansion—(21 to 1550 deg. C.—70 to 2820 deg. F.)	0.0000042
Constancy of volume	No appreciable change at 1550 deg. C. (2820 deg. F.)
Thermal conductivity—(C.G.S. units—200 to 1000 deg. C. or 390 to 1830 deg. F.)	0.0046
Apparent porosity	20 to 23%
Spalling resistance	No loss in standard ASTM panel spalling test.

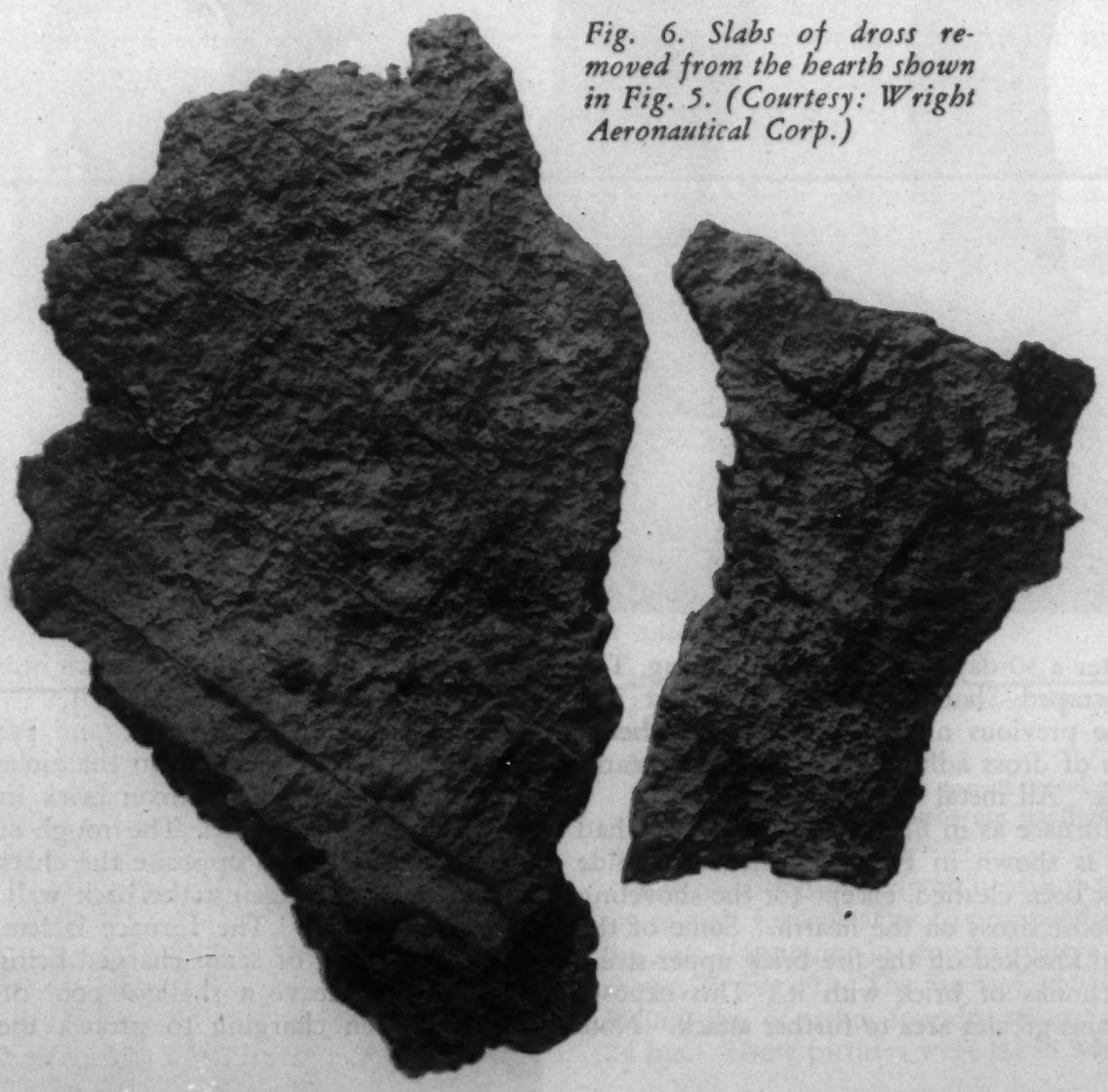


Fig. 6. Slabs of dross removed from the hearth shown in Fig. 5. (Courtesy: Wright Aeronautical Corp.)

Surface Treatments for Magnesium

Part 2

By EMMETTE R. HOLMAN and JAMES P. ApROBERTS

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The first instalment of this useful article, published in our November issue, described methods and equipment to be used in pretreating, cleaning, pickling and chemically finishing magnesium alloys. This concluding portion covers additional chemical processes, plating procedures and organic coatings.

—The Editors

"Alkaline Dichromate" Treatment: Machined parts having previously applied coatings which cannot be removed without affecting dimensional tolerances can be treated by this method. It produces dark gray to black coatings depending upon time of treatment, bath condition, and alloy composition. Like the acid dichromate treatment, it produces no dimensional change and does not affect brass, bronze, and steel inserts except cadmium and aluminum. Also high manganese alloys, such as Dowmetal M and Mazlo AM3S, do not coat uniformly by this process. The salt water corrosion resistance is good and the abrasion resistance is superior.

The work is first cleaned as above described, then given the same 5-min. treatment at room temperature in 15 per cent hydrofluoric treatment as for the acid dichromate process and rinsed in cold running water. It is then immersed for 45 min. in a boiling solution made up as follows:

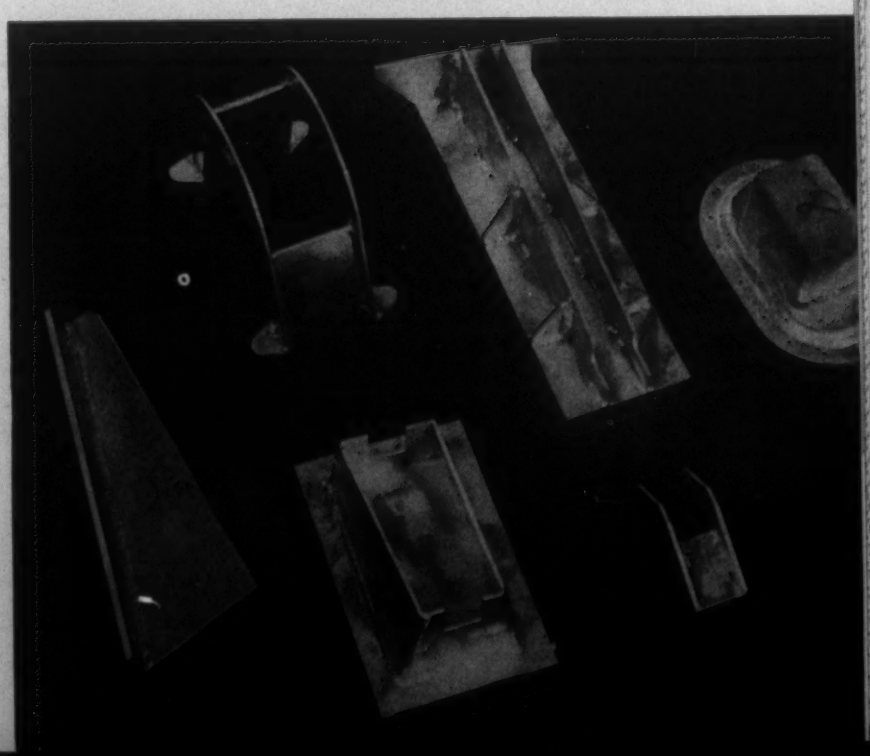
Ammonium sulphate ($(NH_4)_2SO_4$)	4	oz. per gal.
Sodium dichromate ($Na_2Cr_2O_7 2H_2O$)	4	oz. per gal.
Ammonia (Sp. Gr. 0.880)	⅓	fluid oz. per gal.
Water to make	1	gal.

This solution is maintained at pH 5.6 to 6.2 by adding a solution containing 5 per cent each of concentrated sulphuric acid (H_2SO_4) and chromic acid (CrO_3). The dichromated work is rinsed thoroughly in cold running water and then boiled for 5 min. in a 1-oz. per gallon water solution of arsenious oxide. Another cold water rinse followed by a hot water drying dip completes this method. Since the arsenious oxide bath is slowly depleted and has a relatively low cost, monthly replacement is suggested as the most convenient method of control.

"Galvanic Anodizing Treatment": The galvanic anodizing treatment affords especially good protection for high manganese alloys, such as Dowmetal M and Mazlo AM3S, and at the same time provides exceptional abrasion resistance. It is not, however, to be confused with the better known "anodic treatment," commonly called "PT-13d" after the Navy Bureau of Aero. Specification of that name. This treatment produces no dimensional change on machined parts. Its chief disadvantage is allegedly poor throwing power. Properly applied coatings will vary from dark gray to black according to time of treatment, bath condition, and alloy composition.

In performing the galvanic anodizing treatment, the work is first cleaned, nitric-sulphuric pickled for

Some Heliarc welded magnesium airplane production parts. (Courtesy: Northrup Aircraft, Inc., Hawthorne, Calif.)



5 sec. if necessary (to remove previously applied coatings) and immersed for 5 min. in 15 per cent hydrofluoric acid exactly as described above for the "Acid Dichromate Treatment." Following a thorough rinse in running cold water, the work is galvanically anodized in a bath containing ammonium sulphate, sodium dichromate, and ammonia and identical in composition to that used for the Alkaline Dichromate Treatment. This is accomplished by coupling the work with iron or steel cathode plates or with the tank wall through a variable rheostat and ammeter.

This bath may be operated at room temperature but by raising the temperature to around 150 deg. F., the treatment time will be shortened considerably. A current density of at least 2 amps. per sq. ft. must be maintained at all times for 30 min. and must not exceed 10 ASF. If the current density is excessive, loose powdery coatings will result.

In general, the time of treatment is proportional to the current density used and must be long enough to produce a uniform black coating. Between 60 and 150 amp. mins. per sq. ft. will ordinarily be sufficient. The pH of the bath must be maintained between 5.6 and 6.2 by adding a solution containing 5 per cent each of coromic acid (CrO_3) and concentrated sulphuric acid (H_2SO_4) as required.

"Anodic" or "PT-13d": This treatment is applied only to an alloy containing 6 Al, 3 Zn, and 0.2 per cent Mn, *i.e.* Dowmetal H or Mazlo AM265. The presence of foreign metals such as brass, iron, aluminum, etc. in an assembly does not adversely affect the quality of the anodic film on magnesium. With the exception of bearing metals, the foreign metals are also unaffected. Accordingly, magnesium alloy engine castings in the process of fabrication are anodically treated after machining and installation of studs, inserts, etc. Machined surfaces show no change in dimension due to anodizing. The coating produced is dense, adherent and black, but a color varying from gray through green to black is acceptable. Contact marks are unavoidable but must be kept as small as possible.

The work is cleaned and given the 5-min. immersion at room temperature in 15 per cent hydrofluoric acid as in the previous treatments. After thorough rinsing in cold running water, the work is suspended from the anode bar in the anodizing solution and anodized for 45 min. The electrolyte is of the following composition.

Sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$)	13.4 oz. per gal.
Mono sodium phosphate ($NaH_2PO_4 \cdot H_2O$)	2.67 oz. per gal.

The current density required will be 5 to 10 ASF, the exact value to be determined by experiment. Burning (that is a powdery formation at the edges and projections on the parts) may usually be prevented by reducing the current density. The temperature of the electrolyte is 122 deg. F. plus or minus 4 deg. F. and the voltage is 3 to 6 volts. The pH is measurable by means of a glass electrode pH meter and is maintained between pH 4.2 and 4.8 by additions of phosphoric acid as required.

Immediately after anodizing, the parts are thoroughly rinsed in cold running water, then in hot water to facilitate drying.

Tank Materials

Ordinary steel or iron tanks are satisfactory containers for cleaning (in the electro-cleaning cathodically, substitute anodes should be used) sodium dichromate, ammonia, arsenious oxide, and subsequent rinse solutions. For the others, these and similar materials should be used as follows:

1. Nitric-sulphuric pickle. ceramic, rubber lined or pure aluminum.
2. Sulphuric acid pickle. . lead-lined or ceramic.
3. Chrome-pickle . . . . . pure aluminum, glass or ceramic.
4. Hydrofluoric acid . . . . lead or lead lined.
5. Boiling chromic acid. . aluminum, stainless steel or lead.

Nickel Plating on Magnesium

Recent work has shown that magnesium alloys can be plated with nickel or silver. The following procedures have been used. For either process the first step is cathodic cleaning in either a suitable proprietary cleaning solution or one made up of the following approximate composition operated at 160 to 190 deg. F.

Sodium carbonate ($Na_2CO_3 \cdot 10H_2O$)	7.4 oz. per gal.
Trisodium phosphate ($Na_3PO_4 \cdot 12\ H_2O$)	14.5 oz. per gal.
Sodium hydroxide ($NaOH$)	3.7 oz. per gal.
Sodium metasilicate (Na_2SiO_3)	7.4 oz. per gal.
Wetting agent (such as sodium or ammonium lauryl sulphate)	0.9 oz. per gal.

A current density of 50 to 200 ASF is applied for from 1 to 2 min. Cleaning is followed by thoroughly rinsing the parts in first hot and then cold water.

For nickel plating the work is then given about a 5-sec. dip in the following bath:

Chromic anhydride, C.P. (CrO_3)	15.8 oz. per gal.
Nitric acid, C.P. (HNO_3) (Conc.)	10.4 oz. per gal.
Sulphuric acid, C.P. (H_2SO_4) (Conc.)	0.007 oz. per gal.

Operated at approximately 70 deg. F. or room temperature.

To eliminate chromic acid carry-over into the next solution, the work must be thoroughly rinsed in cold water (use a spray or running water where possible). It is then given a second etching treatment of from 1 to 5 min. in a solution composed as follows:

Hydrofluoric acid, 52% HF	22.0 oz. per gal.
Nitric acid, C.P. (HNO_3) (Conc.)	1.1 oz. per gal.

Operated at approximately 70 deg. F. or room temperature.

It is worth noting that the first acid etch replaces the magnesium hydroxide film formed during cleaning with a chromate film. The presence of only a small but definite amount of sulphuric acid makes the film more readily removable later. The nitric acid is said to increase the etching action and improve subsequent adhesion by giving the surface a more "toothed" effect.

In the hydrofluoric acid (HF) etch the chromate film is dissolved and replaced by one of magnesium fluoride.

The nickel fluoride solution which is used should

be made up according to these instructions: First, dissolve 8.8 oz. per gal. ammonium fluoride (NH_4F) and 4.6 oz. per gal. of boric acid (H_3BO_3) in water. Secondly, add enough 52 per cent hydrofluoric acid (HF) to reduce the pH to about 5.8 or 6.0 before adding 7.9 oz. per gal. of nickel sulphate ($NiSO_4 \cdot 6H_2O$). To reduce pitting that may be caused by suspended matter, it is recommended that a small amount (approx. 0.004 oz. per gal.) of a suitable wetting agent be added. Finally, add enough 52 per cent hydrofluoric acid (HF) to bring the pH down to 5.5.

This solution is operated at close to 102 deg. F. (probably with lead or other insoluble anodes) and a c.d. of 10-30 ASF. Under the foregoing conditions, a smooth, relatively pit-free deposit, approximately 0.001 in. thick is obtained with good adhesion and fair corrosion resistance.

Unsatisfactory nickel coatings can be stripped easily by anodic treatment (over a wide range of c.d. in a solution of about 25 per cent hydrofluoric acid (HF) and 10 per cent nitric acid (NHO_3). As the nickel goes into solution, the work polarizes due to the formation of a substitute coating of magnesium fluoride, MgF_2. When it is completely polarized as indicated by a current drop to zero, the work can be thoroughly rinsed in cold water and replated in the nickel bath.

It is interesting to note that the best corrosion resistance was obtained with a triple plate of nickel, then buffed cadmium and finally buffed nickel (to reduce porosity) having a total plate thickness of 0.001 to 0.0015 in. It withstood about 20 hrs. of salt spray before pitting developed, while a single 0.001-in. nickel film may be safely used in atmospheres protected from excessive moisture.

Heliarc welding. Parts are bathed in non-inflammable helium gas. A tungsten electrode provides contact. (Courtesy: Northrup Aircraft, Inc., Hawthorne, Cal.)

Silver Plating

The work is first cleaned cathodically as described above for nickel plating, and is rinsed in cold running water. It is then anodized for 3 to 6 min. in a solution containing trisodium phosphate ($Na_3PO_4 \cdot 12H_2O$) 25 per cent, at a current density of 275 to 375 ASF. The electrolyte is heated to 140 to 175 deg. F. This produces a stable, adherent, smooth gray anodic film. The anodized parts are then given a cold water rinse and the copper strike in a bath of the following composition:

Copper cyanide	0.67 oz. per gal.
Potassium cyanide	13.3 oz. per gal.
Temperature	68 to 77 deg. F.
Current density	270 ASF

After the magnesium is completely covered with copper, it is given a thorough cold water rinse and silver plated in the following electrolyte:

Boric acid	1.3 to 4.0 oz. per gal.
Silver cyanide	1.1 oz. per gal.
Potassium cyanide	1.5 oz. per gal.
Anodes — High purity silver	
current density	1.8 to 4.3 ASF
Temperature	68 to 77 deg. F.

Anode to cathode ratio 1 to 6 max., larger anodes produce poor deposits.

The deposits are hard, smooth and white. Thicknesses under 0.001 in. are quite adherent.

Organic Coatings

Like chemical treatments, the purpose of applying organic coatings to magnesium articles is chiefly protective although their decorative value is not to be overlooked. In fact, the maximum protection of magnesium is obtained by a combination of chemical and organic coatings with the very best results being derived from applying paint coatings as soon as possible after treatment in order to secure the maximum adhesion which is afforded by the more porous surface condition existing at that time in addition to the greater freedom from possible contaminants.

In such a combination, the effectiveness of the organic coatings is dependent upon previous surface treatment, adhesion, impenetrability and any corrosion inhibiting properties resulting from the pigment employed in the primer as well as subsequent coatings. Each of the previously mentioned surface treatments is recommended as satisfactory paint base provided, of course, that no contamination occurs upon the surface between processing and painting operations.

If cleaning is necessary, vapor degreasing or a solvent wipe or wash may be used. In the latter instance the solvent chosen should be similar to that which may be used as a diluent for the finishing material to be applied in order to assure compatibility. The cleaners previously discussed are not recommended since they might tend to impair the coating.

Finishing Materials and Systems: A number of finishing systems using primers, surfacers, enamels and varnishes approved by magnesium producers and government agencies have been developed to cover the correct painting of magnesium. The present use of this metal for war purposes exclusively has been interpreted to limit this discussion to covering the application of primers and finishing coats used in protecting parts exposed to a variety of service conditions.

In the use of a primer, choice of both vehicle and pigment are important, especially if corrosive conditions are anticipated. A satisfactory vehicle is one which, in addition to being impervious to moisture, has good adhesion qualities and is receptive to the type of pigment used. At present varnishes of moderate oil length which are made entirely of phenolic resins are giving excellent results.

Extensive tests on pigments have shown that one composed essentially of zinc chromate is the most satisfactory. This is due no doubt to the corrosion inhibiting properties of zinc chromate. At present most finishing systems are based upon the use of one or two coats of a zinc chromate glyceryl phthalate primer which conforms to the latest issue of Army No. 14080 or Navy P-27b-2 or AN-TT-P-656a. Baking or forced air drying will not only speed up drying time but also improve adhesion and abrasion resistance for primers as well as finishing coats.

Applying the Final Coatings: The number and type of finishing coatings applied over a primed magnesium surface varies according to conditions anticipated. For satisfactory results under severe conditions it has been found that three finishing coats or more may be needed. The properties most essential to finish coatings are adhesion and imperviousness. As in the case of primers, they are based upon the vehicle and pigment employed.

Phenolic resin varnishes with a moderate oil content (20 gal. phenolic resin for example) again appear to be most satisfactory. Their adhesion and imperviousness as well as durability can be improved by forced air drying or baking as well as the inclusion of a pigment with high moisture impedance. In this last respect it has been shown that aluminized coatings have the best rating.

The method and technique of applying organic coatings is always an important factor affecting their performance.

The above-mentioned primer coatings can be dipped or sprayed. Finishing coats, however, should be sprayed as due care must be given to see that all sections are evenly coated. In painting castings it may be found advisable to preheat them immediately before priming under ordinary baking conditions in order to expel any otherwise interfering gases which would affect the primer.

Bibliography

1 *Metal Finishing (N. Y.)*, Vol. 40, 1942, pp. 84-87.
2 *Metal Finishing (N. Y.)*, Vol. 39, 1941, p. 642.
3 "Symposium on Surface Treatment of Metals," American Society for Metals, 1940, pp. 36-68.
4 *Proceedings, A.S.T.M.*, Vol. 41, 1941, pp. 15-22.
5 "Dowmetal Magnesium Alloys," Dow Chemical Co., 1941.
6 "Magnesium—Surface Treatment and Protection," American Magnesium Corp.
7 "Problems and Methods for Plating on Magnesium," by J. P. ApRoberts, *Monthly Review*, Am Electroplaters' Soc., Mar. 1943.
8 "Nickel Plating Magnesium Alloys," by W. S. Loose, *Trans. Electrochemical Soc.*, Vol. 81, 1942, Preprint 6.
9 "Silver Plating Magnesium Alloys," by F. J. Bowens and L. 1. Gilbertson, *Trans. Electrochemical Soc.*, Vol. 83, 1943, Preprint 1.

Some Modified "Heavy Metal" Alloys

—Effect of Composition on Properties

by HENRY H. HAUSNER

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The high-density tungsten-nickel-copper powder metallurgy "alloys," christened "heavy metal" when developed by Smithells in England a few years ago, have considerably broadened their applications since. For some of these newer uses certain modification of the material would seem desirable, and in this article the physical and electrical properties of such modified alloys are reported. —*The Editors*

ONE OF THE MOST INTERESTING products of powder metallurgy is Smithells "Heavy Metal."[1] Basically heavy metal or heavy alloy is "composed of tungsten, nickel and copper, has a density of not less than 16 gr. per cc. and consists of large grains of tungsten cemented together by a copper-nickel-tungsten alloy, there being not more than 1500 grains of tungsten per square millimeter of section of the material." According to the patent, the composition of the mixture lies within a range of 3½ to 16½ Ni, ½ to 13½ Cu and 83 to 96 per cent W.

A special composition of this material of 2 Cu, 5 Ni and 93 per cent W was subsequently described by Price, Smithells and Williams,[2] and information

Compositions and Properties of Various "Heavy Metal" Alloys

Alloy No.		A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Composition, per cent	W	90	90	90	90	84	84	84	84	76	76	76	76
	Ni	7	5	3	1	11	8	5	2	16	12	8	4
	Cu	3	5	7	9	5	8	11	14	8	12	16	20
W/Ni Ratio		12.9	18	30	90	7.6	10.5	17	42	4.8	6.3	9.5	19
Ni/Cu Ratio		2.33	1	0.43	0.11	2.2	1	0.45	0.14	2	1	0.5	0.2
Sintering Temp., deg. F.		2510	2425	2375	2265	2510	2425	2375	2265	2510	2425	2375	2265
Theoretical Density		17.6	17.6	17.6	17.6	16.9	16.9	16.9	16.9	16.2	16.2	16.2	16.2
Density after Sintering		13.6	13.3	14.3	13.6	13.1	12.8	14.2	13.2	12.4	11.8	13.9	13.2
Density after working and annealing		16.6	16.5	16.7	16.6	15.5	15.4	15.6	15.6	15.0	14.4	14.6	14.5
Elec. Conductivity %, I.A.C.S.		16.5	17	17.5	19	13	14.2	15.5	17	9.8	11.5	13.3	15.4
Tensile strength, 1,000 p.s.i.		60	86	105	78	84	93	93	68	96	90	78	60
Brinell Hardness		213	218	238	248	208	214	214	208	170	220	185	176

was presented on physical properties of this material, especially in regard to different grain sizes and variations in sintering-time and sintering-temperature.

Applications

Originally developed for a single application, alloys of the heavy metal type have demonstrated a diversity of uses that indicate their future to be among the brightest for powder metallurgy products.

The high densities of certain types of the material with 90 per cent W (or more) make these types valuable for being used as containers for radium. The radiation absorption coefficient of this type of high-density material is 30 to 40 per cent higher than the absorption coefficient of lead. Again, heavy metal and other tungsten-nickel-copper compound materials may be used to balance crankshafts of aeromotors, for balance weights on controllable-pitch airscrews or for the centrifugal clutchplates which provide the slipping mechanism for supercharger drives and the like.[3]

Apart from these applications, tungsten-nickel-copper compounds may be used successfully in the rotors of gyroscopes and gyro-compasses where a concentrated mass, combining high strength and resistance to creep is required. For these purposes a material with optimum qualities of density, of tensile strength and elongation has to be used. In fact a material *with less density* but better tensile strength and especially with higher elongation is preferable for uses such as these.

Tungsten-nickel-copper compound materials may also be used for sparking contacts in air circuit breakers. Their ability to withstand material transfer, their relative good conductivity and high hardness permit the use of these materials, where high currents, like short circuit currents, may be expected and contact wear has to be avoided. Obviously in these applications high conductivity and hardness are more important than density.

It is now clear, therefore, that the broad type of material loosely called "heavy metal" has several applications and that some of these require different properties or combinations of properties than others. The author therefore undertook to study several different compositions of heavy metal and to develop modifications thereof, for the purpose of finding specific alloys that would be individually best suited for particular types of applications — in other words, of establishing which compositions had the best conductivities, which the greatest hardness, which the highest density, which the most tensile strength, and so on.

In the following paragraphs are described the physical properties of different tungsten-nickel-copper compound metals, broadly similar to Smithells heavy metal but with densities of 16 gr. per cc. and less, to show the influence of composition on different physical properties, especially on tensile strength. Systematic studies were made on samples of a series of 12 different compositions (given in the Table) and in addition on a few compositions with a very small amount of nickel (2% and less).

Processing

For these 12 different compositions the same types and sizes of metal powders were used, according to the following specifications:

(a) Tungsten powder size —200 mesh, of the American Electro Metal Corp.

(b) Commercial fine electrolytic copper powder, Type G, of General Metals Powder Co.

(c) Commercial electrolytic nickel powder in a size of —300 mesh, of Charles Hardy, Inc.

These powders were mixed dry and then pressed with an initial pressure of 50 tons per sq. in. No wax or benzol was used as a lubricant. The compacts obtained in this way were sintered in a hydrogen atmosphere for 4 hrs. No lubricant being used, preheating for evaporation was not necessary.

The sintering temperatures were different for the individual compositions. In any case the sintering temperature had to be higher than the liquidus of the copper-nickel system and at least as high as the recrystallization temperature of tungsten. Recrystallization, even if associated with grain growth, gives a greater strength than the uncrystallized compact.[4]

It was decided therefore to sinter the 12 samples at temperatures higher than 1200 deg. C. (2200 deg. F.), even in cases where the melting point for a given copper-nickel mixture is less than 1200 deg. C. (2200 deg. F.) Such treatment was believed sufficient to promote adequate diffusion between the copper and nickel phases on the one hand and between their binary system and tugnsten on the other hand. After 4-hr. sintering time the material was examined and again heated for a short time at approximately 800 deg. C. (1475 deg. F.) in a hydrogen atmosphere to be prepared for hammering in the hot state. The density increased very much during the hot hammering, as expected. After hammering the samples were annealed again for 1½ hrs. in a stream of hydrogen at temperatures approximately 25 deg. C. (45 deg. F.) lower than the individual sintering temperatures. After this annealing the material was machined.

The changes in microstructures during the sintering of such compacts as these are ably described by Smithells in both the U. S. patent and in the above-mentioned article.[2] The microstructures of the 12 alloys tested by the author show in a few cases some deviations from the structure described by Smithells.

In some cases materials of quite different compositions showed similar structures and grain sizes, despite the fact that one was sintered *above* the melting point of the nickel-copper alloy and above the recrystallization temperature of tungsten, while another was sintered *below* these temperatures. On the other hand considerable differences in structure were observed between materials of equal tungsten contents but sintered at different temperatures. Sintering temperatures of 1380 deg. C. (2510 deg. F.) seemed to produce grain growth whereas those of 1330 deg. C. (2425 deg. F.) and below did not.

The significant conclusion here was that the densities of these materials depend only slightly on their structures but heavily on the tungsten content.

Properties of the Various Materials

Density—Density determinations were performed, using the weight-of-a-measured-volume method for all samples. In all cases (see the Table), the actual densities were less than the theoretical densities.

The difference between the theoretical and actual densities depends on the amount of tungsten, being the least at the highest tungsten content studied. The greatest final densities were also obtained in the 90 per cent W materials. Such materials are therefore best for applications of the radium-container type, where density is a prime factor.

Electrical Conductivity—The electrical conductivity of a tungsten-nickel-copper compound material is generally determined by its *nickel* content. The tungsten-copper ratio plays no important role. These conclusions can be drawn from data published by Schenk and Dean,[5] who demonstrated, for example, that a compound material of 60 W, 39.5 Cu and 0.5 per cent Ni gives a better electrical conductivity than one containing 20 W, 79 Cu and 1 per cent Ni.

The results of the present author's tests for conductivity are given in the Table. The highest-nickel material has the lowest conductivity and the lowest nickel the highest conductivity. A similar correlation holds for the tungsten/nickel ratio — the higher this is, the higher will be the conductivity. Strangely enough the copper content is relatively unimportant. Fig. 1 shows graphically the effect of the tungsten/nickel ratio on the electrical conductivity.

The lowest-nickel alloys are thus best for applications requiring maximum conductivity.

Tensile Properties and Hardness—The tensile strengths obtainable in this series of materials depends *partly* on the tungsten content and *partly* on the nickel/copper ratio. The highest (as well as the lowest) tensile of the series was found in a material with the maximum tungsten content (90 per cent). The effect of composition on tensile properties is best shown in Fig. 2.

For each tungsten content there is a definite nickel-copper ratio that provides a maximum tensile strength. This maximum tensile strength will be higher, the higher the tungsten content; also the nickel-copper ratio that is best increases as the tungsten content decreases.

The elongation values for the entire series fell between 1 and 4 per cent. For a given tungsten content, the maximum elongation was found in the material with the highest tensile strength. However the elongation decreased as the tungsten content increased.

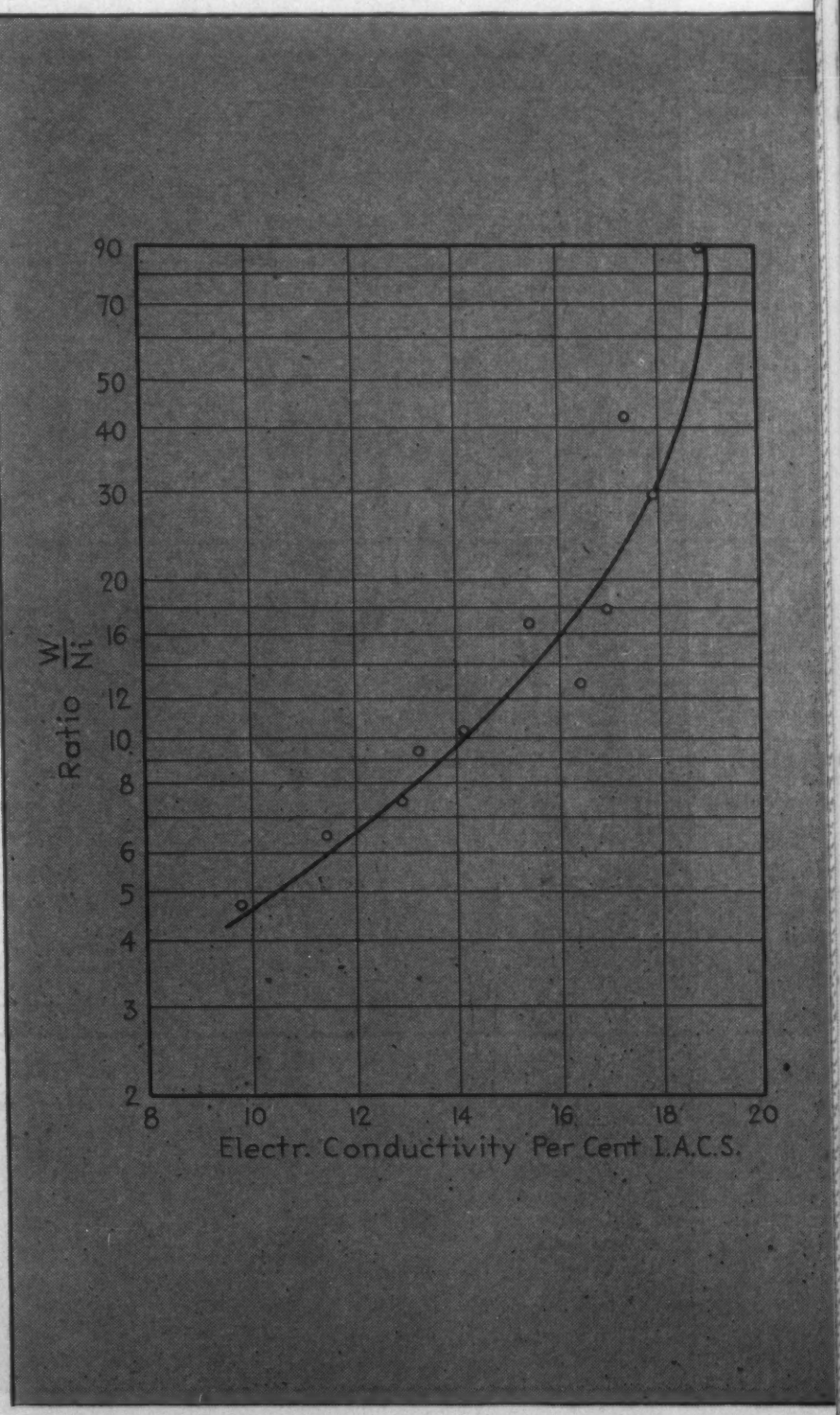
Where tensile properties are a factor in an application, therefore, one may choose from among three or four compositions, with one eye on other properties (say conductivity or density) that may also be important. Material A3 would be best for service requiring a combination of tensile strength, density and conductivity.

Rockwell hardness tests were made on the 12 materials and the values converted to the Brinell figures given in the Table. As would be expected the hardness increases roughly with increasing tungsten content. The alloy with the highest hardness (and also the highest conductivity) is A4, 90 W, 9 Cu and 1 per cent Ni.

Conclusions

In the foregoing paragraphs it has been shown that the different physical properties of tungsten-nickel-copper compound materials required for different services may be obtained by changing the percentages of the composition. Although many physical properties are changed in this way, the

Fig. 1. The electrical conductivity of various "heavy metal" compositions, plotted to show the effect of the tungsten/nickel ratio.



machinability of all the described 12 materials remains uniformly excellent, even when the tungsten content is 90 per cent. The described materials can easily be machined with ordinary tools, even in the case of one with a density of 16 gr. per cc. or more. They can be drilled, tapped, knurled and so on without any difficulty.

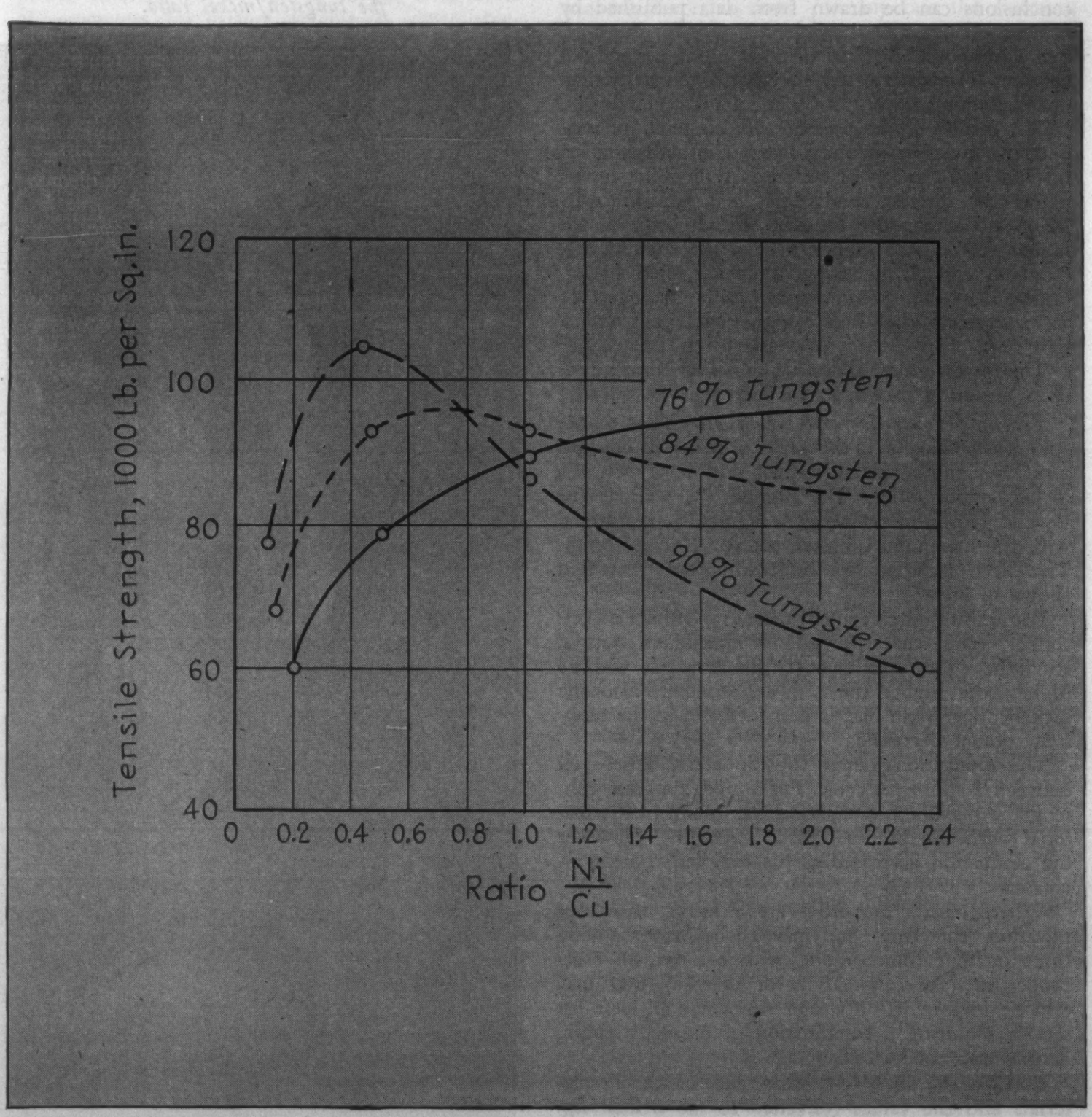
It might be mentioned that brazing or silver soldering of these compound materials to other materials can be done without any difficulty with the use of ordinary fluxes. A special method of welding in hydrogen has been developed to join heavy metal parts together.[3] Such hydrogen welding gives a homogeneous weld which is indistinguishable from the parent alloy and it is said to have identical physical properties.

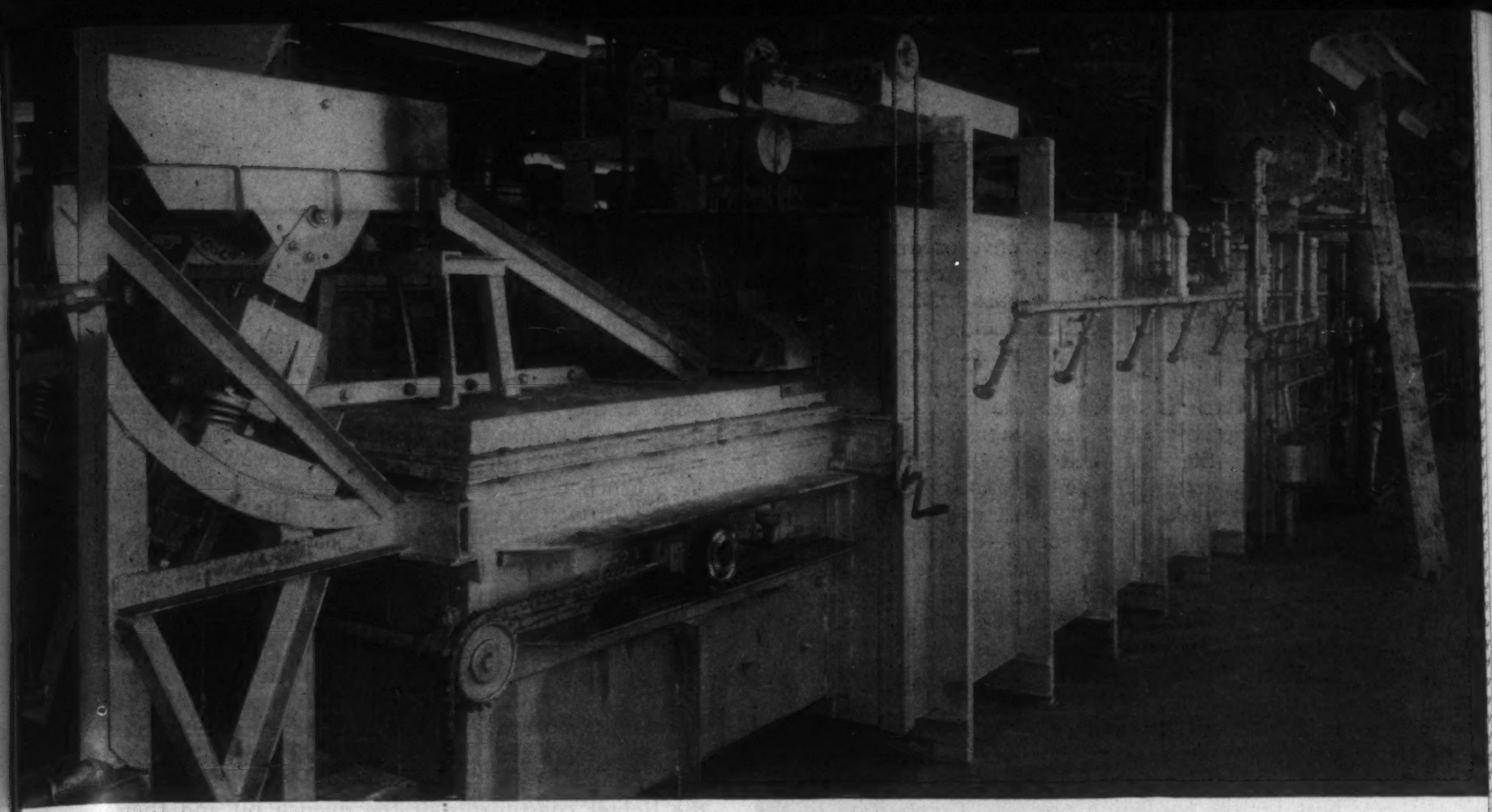
The materials described in this article, somewhat lower in tungsten and with a slightly lower density than Smithells's heavy metal, offer interesting combinations of properties through controlled modification in their compositions.

References

[1] U. S. Patent 2,183,359, "Method of Manufacturing of Heavy Metallic Material."
[2] G. H. S. Price, C. I. Smithells and S. V. Williams, "Copper-Nickel-Tungsten Alloys Sintered with a Liquid Phase Present," *J. Inst. of Metals*, Vol. 62, 1938, page 239.
[3] *The Aeroplane*, (London), Vol. 54, 1938, page 374.
[4] P. E. Wretblad and J. Wulff in "Powder Metallurgy" edited by John Wulff, American Society for Metals, Cleveland, 1942.
[5] Schenk and Dean, "Physical Chemistry of Metals," page 76.

Fig. 2. The tensile strengths of various "heavy metal" compositions, plotted to show the effect of nickel-copper ratio in alloys of the same tungsten content.





Charging end of the Stewart hardening furnace showing automatic feed from degreasers and continuous conveyor controlled atmosphere furnace with atmosphere generator.

Heat Treating Machine Gun Links

by JOHN ADE

Design and Construction Engineer,
Stewart Industrial Furnace Div.,
Chicago Flexible Shaft Co., Chicago.

This is a mass-production war and for mass production good engineering means the maximum of mechanization, especially in the heat-treating field. This article describes a group of 4 continuous clean-hardening and tempering furnace lines now producing 2,640,000 machine gun links per day, and gives all details of mechanization, furnace construction, controls, quenching unit, draw-furnace recirculating equipment, etc. —*The Editors*

MACHINE GUN LINKS are heat treated by heating them to about 1550 to 1600 deg. F. and rapidly quenching in oil to give them hardness. They are then reheated to about 660 to 690 deg. F. to draw or temper them, thereby increasing their toughness. The purpose of the heat treatment is to make the links hard and tough and strong, so that they will hold the cartridges securely and be able to undergo severe stress without becoming deformed. Precision heat treatment turns out links which will take all the punishment of modern warfare, and which will not fail in combat by jamming machine guns in crucial moments.

Machine gun link heat-treating equipment designed to meet rigid operating and metallurgical specifications consists of a hardening furnace, quench tank and a draw furnace. The size, capacity, type, accessories and all special features of a typical installation comprising 4 units, now in regular operation, are described in this article.

The Hardening Furnace and Atmosphere

The hardening furnace is a Stewart furnace of the continuous full muffle type with controlled atmosphere. Each of the four units has a capacity of 1100 lbs. per hr.; a total of 2,640,000 links per day. The overall dimensions of the furnace are 9 ft. high by 6 ft. wide by 29 ft. long. The conveyor belt is 24 in. wide and is 20 ft. long from the point where the links are charged on the belt to the point where they are discharged into the quench tank. Heat resisting alloy is used exclusively in building the conveyor belt to give it long life under the high temperature and heavy load conditions. Wide variations

in belt speed are possible with the variable speed transmission built into the conveyor drive.

If the links were exposed to direct contact with the hot burning gases from the burners, they would become heavily scaled in the hardening process. To prevent entirely the formation of scale, the belt carries the links through a heavy high-temperature alloy muffle, which is built into the furnace not only to protect the links from the combustion gases, but also to confine the controlled atmosphere.

Dry gas units provide the atmosphere which surrounds the links while they are in the furnace. The dry gas is formed by incompletely burning gas in a special combustion chamber and passing the resulting gases through materials that stabilize them. This gas is practically free of all scale-forming constituents. The controlled atmosphere gas is fed into the muffle at the discharge end of the furnace, and when the gas leaves the muffle at the charge end it is hot enough to form a soft flame as soon as it comes in contact with air.

Twelve tangential tunnel type burners provide the heat for the hardening process. Combustion of the pre-mixed gas and air takes place within high temperature refractory tunnels built into the walls of the furnace, thereby preventing the flame from striking the muffle directly. Engineering experience determines the size, spacing and direction of the burners, the size and shape of the combustion chamber and muffle; the contours and opening for the circulation of the gases about the muffle and for the size and location of the flues to insure safe, uniform, thorough heating in a furnace of this type.

In order to provide quick heating in the charge end of the furnace and uniform, very closely controlled temperatures at the discharge end, the furnace is provided with two zones of temperature control. Each zone has its own throttling type pyrometer control, gas-air proportioning valve and mixing equipment. Burners use not over 2000 cu. ft. of city gas per hour, and the dry gas unit about 700 cu. ft. per hr.

The furnace is lined with first quality fire brick and insulated with insulating brick. Fourteen different types of refractory material, each for some special purpose, were used in the construction.

The links are fed onto the conveyor by means of a vibrator feeder which keeps the links piled to a uniform thickness across the belt as well as lengthwise. Constant, unattended tension under stretching, expansion and contraction of the belt is provided by a dead weight type takeup.

Quenching

Good hardening requires thorough heating to the correct temperature, and then just the right quenching. Uniform, economical quenching is provided by the special Stewart quench chute. This unit is designed to make the hot soft links fall free of each other as they drop into the curtain of oil which protects the oil within the quench chute from the intense radiant heat of the furnace. In order to maintain the quench oil at a uniform temperature, the oil is passed through an evaporative type cooling unit. The cooled oil at 125 to 150 deg. F. is all returned to the tank through the water-jacketed quench chute, which gives the oil the correct amount of agitation and motion to harden the links to close limits.

The hardened links are picked up by the quench tank conveyor belt as they reach the bottom of the chute. As the links are carried to the top of the conveyor, the warm oil drains off reducing the carry-off to a minimum. To promote circulation of the oil within the tank and to prevent stratification of the lighter constituents of the quench oil and their surface evaporation, 150 to 200 gal. of oil are skimmed from the surface every minute.

This oil flows into the sump where it passes through a strainer, and then it is pumped through the cooling unit and back to the quench chute. Maximum flexibility in operating and servicing is provided by a piping arrangement which makes it possible to take oil from any of the four quench tanks, pump it through any of the four cooling units, and return it to any quench tank without interfering with any other units which are operating.

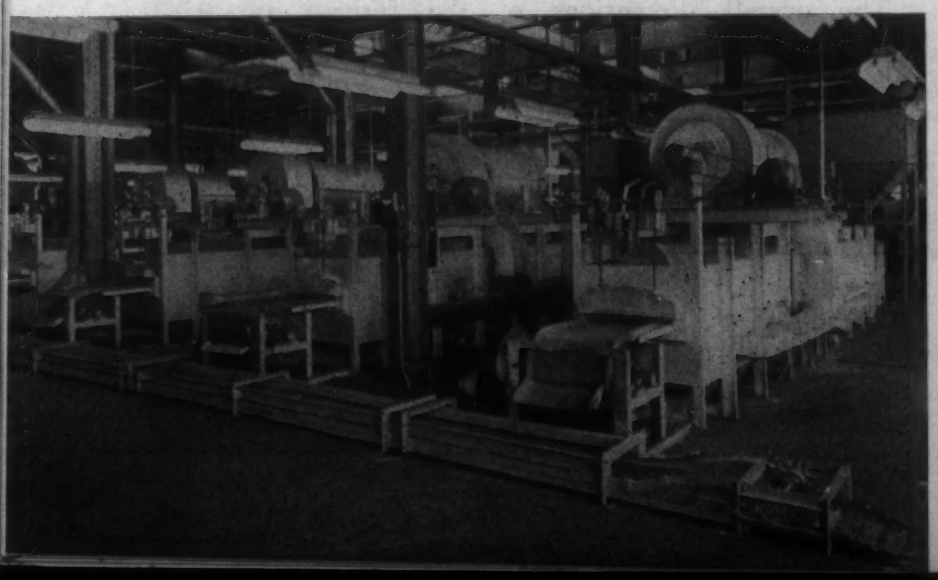
The quench tank is 5 ft. wide, 12 ft. long and 7 ft. deep, and it holds about 2,000 gal. of oil. The conveyor extends from the bottom of the tank to 9½ ft. above the tank and about 9 ft. beyond the discharge end of the tank. Wide variation in conveyor speed rate is possible due to the variable speed drive.

A Continuous Draw Furnace

The draw furnace is of the continuous recirculating type. The overall dimensions of the furnace are 9 ft. high by 7 ft. wide by 35 ft. long. Links are carried through the 25 ft. of the furnace proper on a 24-in. wide conveyor belt.

In order to keep the variation in hardness of millions of links within minute limits, every link must be taken through the same heating cycle. Even rela-

Discharge end of the air draw furnaces from which the links are carried automatically by conveyor to the final manufacturing process.



Hopper feed of hardened and quenched links to the air draw furnaces. Note that there are four complete lines in this one installation.

tively small temperature variations will cause a link to give a Rockwell hardness reading too high or too low. Uniform results day after day are assured by the combination of the conveyor which carries all the links through the entire length of the furnace, the recirculation fan which blows 7000 cu. ft. of hot gases through the load per minute and the throttling type of temperature control which holds the furnace temperature right where it is wanted.

The big recirculating fan pulls the gases from above the links in the furnace, mixes in a small amount of hot gas from the burner to supply heat absorbed by the links and to replace the gases vented out the doors to keep air out of the furnace, and then forces this uniformly heated mixture through the ducts to the bottom of the furnace and up through the links. The air in the furnace is changed over 100 times every minute with a velocity of about 1300 ft. per min. through the links.

The combustion unit has one atmospheric burner which is furnished premixed gas and air from an injector. Full protection against explosion is provided by the Wheeler Flame-otrol and Airflow switches which would shut-off the gas if the burner went out for even an instant, or if the recirculating fan should stop. The draw furnace requires about 900 cu. ft. of city gas per hour.

The draw furnace conveyor, like the hardening furnace conveyor, has a variable speed drive, and is fed an even flow of links by means of a vibrator feeder.

High quality refractories, with especial emphasis on insulating properties, are used throughout the draw furnace. The shells of the draw furnaces and hardening furnaces are of welded heavy steel construction.

Part of the belt conveyor which takes the links from the quench tank.

EDITORIALS—*(Continued from page 1313)*

for the first half of 1943 was at the rate of 4.9 per cent per year as compared with 5.3 per cent a year ago.

A major factor in the decline in earnings is stated to be a sharp increase in total payrolls—for the first 6 months of this year they were 30 per cent more than for the same period in 1942. Evidently labor has not suffered as to income. Stockholders, however, have had to take less—dividends paid this year were equivalent to 5.6 cents per dollar distributed in payrolls compared with 7.5 cents per payroll dollar in the first 6 months of 1942. Stockholders' dividends to July 1, this year, are down 5 per cent from dividend payments in the same period in 1937.

While the steel industry has done and is doing a magnificent job in providing war material, it cannot be justly accused of profiteering. The situation is due largely to Government regulation of prices and to taxes. Even if there were any desire on the part of steel executives to take any undue advantage of the great volume of business, it would not be possible under present regulations. —E.F.C.

Productivity

In a recent radio broadcast, a prominent manufacturer, defending America's high wage scale, stated that the productivity of the American workman is so high that our costs per unit are usually lower than in low-wage countries. This is perfectly true, but it tells only half the story.

Most people realize only vaguely just why the American workman is the world's most productive. The Englishman, or Czech, or German, or Swede, is as intelligent. Chinese or Hindus are as diligent. In individual skill, it is perhaps significant that an American company desiring to make precision gage blocks brought over Swedish machinists to start their production.

Our engineers supply the real reason. American engineers are admittedly the world's leaders in mass production techniques. Their genius has lain in devising processes which lend themselves to high-speed fabrication; in breaking-down of operations to simple units; to adapting or inventing machines, often automatic or semi-automatic in operation, for performing difficult operations. In such devices as the automatic screw machine, the metal-forming press, and the spot welder we see the reason why America is the land of the automobile, the refrigerator, the washing machine and the radio—and 50,000 war planes per year. The American workman is a high level producer because the engineer has put into his hands the tools and processes of mass production. —K.R.

A Collection of Corrections

Because the people who write for and edit METALS AND ALLOYS are only human, something approaching the expected percentage of man-made errors creeps into our otherwise sacrosanct columns. Since some of the errors involve numerical data, we hasten to correct a few observed in recent issues.

Two typographical slips in the very carefully checked "Engineering File Facts" should be particularly noted. In the July issue in "File Facts" No. 18, Table V, page 79, the melting point of the silver solder to be used is actually 1200 deg. F. rather than the 1350 deg. F. erroneously printed there.

Then, a transposition in the values for both thermal and electrical conductivities in "File Facts" No. 22, in the September issue, page 529, caused the data for nickel to be listed for nickel-chrome, and vice versa. Readers who save these pages for their files should mark in these corrections.

In the article on "Resistance Welding" in the September issue, two of the captions on page 520 were inadvertently transposed. The diagram described as that of the flash butt process is really that for upset butt welding, and vice versa. And the upper-left-corner diagram illustrates projection (not "production") welding.

Finally, in reference to the article on precision castings by J. D. Wolf in our October issue, we have been advised that a number of patents have been issued in this field and that T. G. Jungersen of Summit, N. J., holds many of them and claims that the designs and processes described in this article are covered by his patents. —The Editors

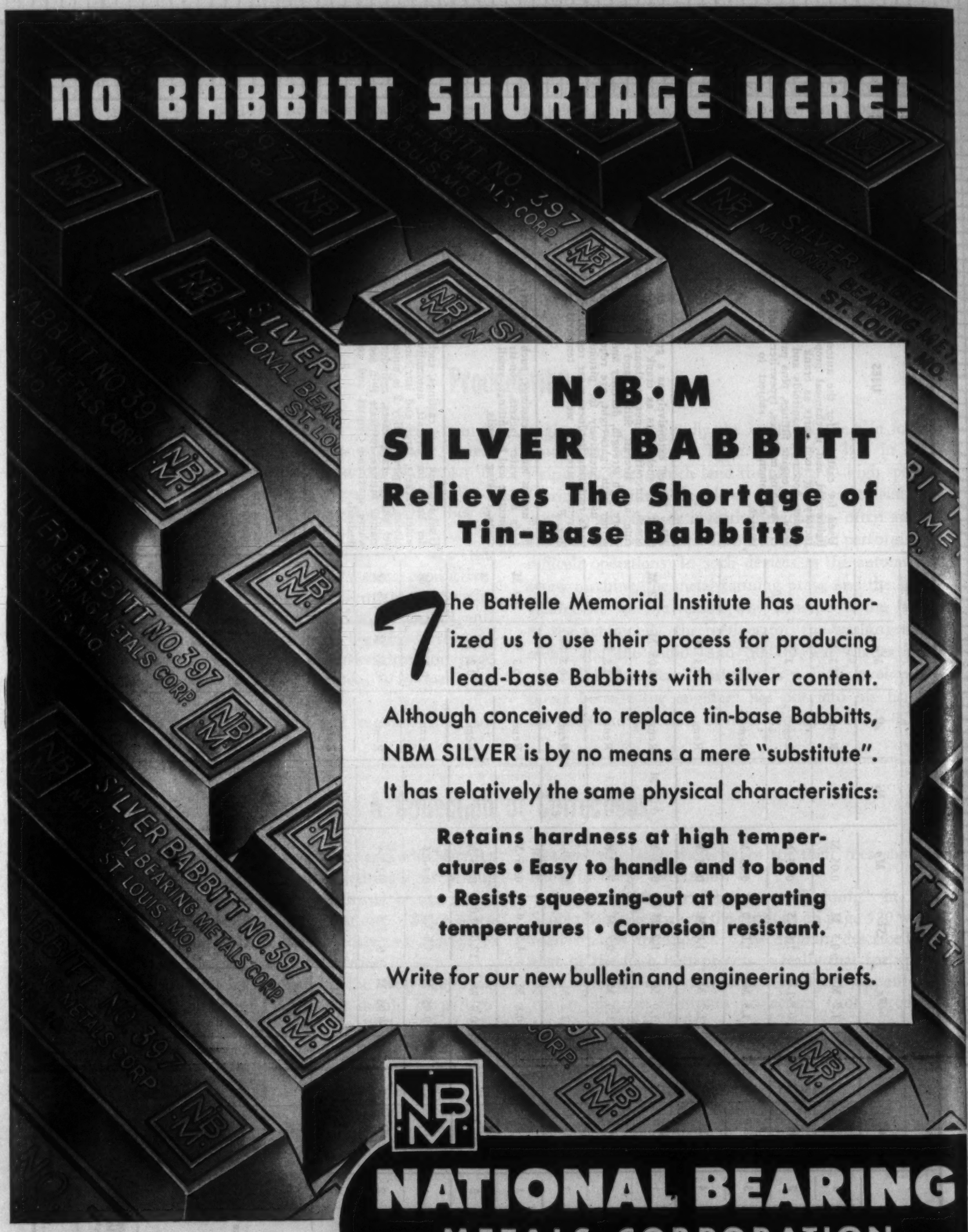
Light Metal Casting Alloys

Composition and Properties

TYPE		COMPOSITION, PER CENT									USES
		Cu	*Zn*	*Fe*	*Si*	*Mg*	*Ni*	*Al*	*Mn*	*Ti*	
Non heat-treated aluminum copper alloys (sand cast)	1	7.0-8.5	0.2 M	1.2 M	0.5 M	0.05 M		Rem.	0.3 M		Used for castings for the automotive industry where lightweight and mechanical properties are quite satisfactory for such parts as crank cases, oil pans, transmission housings, manifolds and miscellaneous chassis, body and engine fittings, plus parts for vacuum sweepers, washing machines, typewriters, and other appliances and equipment not subject to extreme stresses and impact.
	2	7.0-8.5	0.2 M	0.8-1.4	1.0-1.5	0.05 M		Rem.	0.3 M		
	3	6.0-8.0	2.2 M	1.5 M	1.0-3.0	0.05 M		Rem.	0.3 M		
	4	11.0-13.5	0.2 M	1.2 M	1.0 M	0.05 M		Rem.	0.3 M		
Heat-treated aluminum-copper alloys (sand cast)	1	4.0-5.0	0.05 M	1.0 M	1.2 M	0.03 M	0.05 M	Rem.	0.05 M	0.2 M	Alloy 1 used extensively as a general engineering material for such parts as crank cases for truck, motor coach, aircraft engines, outboard motor castings, marine and aircraft fittings and numerous other parts where high strength, ductility and impact resistance, together with lightweight, are required. Alloys 2 and 3 are used extensively for pistons, bearings and other parts requiring hardness wear resistance and the ability to retain strength well at temperatures of 500-600 deg. F.
	2	3.5-4.5	0.1 M	1.0 M	0.7 M	1.2-1.8	1.7-2.3	Rem.	0.3 M		
	3	9.2-10.8	0.2 M	1.5 M		0.15-0.35		Rem.	0.3 M		
Non heat-treated aluminum-silicon alloys (sand cast)	1	0.4 M	0.2 M	0.8 M	4.5-6.0	0.05 M		Rem.	0.3 M	0.2 M	For use in marine castings, such as water-cooled manifolds and water jackets, non-structural aircraft parts, automotive and bus fittings, small motor housings, meter cases, cooking utensils.
	2	0.15 M	0.1 M	0.8 M	12.0-13.0	0.05 M		Rem.	0.2 M		
Heat-treatable aluminum-silicon alloys (sand cast)	1	1.0-1.5	0.05 M	0.05 M	4.5-5.5	0.4-0.6		Rem.	0.1 M	0.2 M	Used for leak proof castings, such as water-cooled cylinder heads for aircraft, automotive and Diesel engines, water jackets, large and intricate crank cases, cylinder blocks, oil pans. Alloy 2 is suited for marine and Diesel engine crank cases, cylinder blocks and oil pans, marine fittings, intricate thin sections and castings and where maximum impact and corrosion resistance are desired.
	2	0.2 M	0.05 M	0.05 M	6.5-7.5	0.2-0.4		Rem.	0.05 M	0.2 M	
	3	1.2-1.8		0.6 M	4.5-5.5	0.4-0.6	0.5-1.0	Rem.	0.5-1.0		
Magnesium-base alloys (sand cast)	1	0.05 M	0.3 M		0.5 M	Rem		9.0-11.0	0.10 M		Used mainly in transportation industry, in construction of parts for portable tools, in construction of reciprocating parts of automatic equipment, where weight saving is important, air plane crank cases, starting equipment instrument housings, supercharger parts, landing and tail wheels, etc.
	2	0.05 M	0.3 M		0.5 M	Rem		11.2-12.8	0.10 M		
	3	0.05 M	2.5-3.5		0.5 M	Rem		5.3-6.7	0.15 M		
	4	0.05 M	0.5-1.5		0.5 M	Rem		9.0-11.0	0.10 M		
Aluminum-copper-silicon alloy (sand cast)		3.5-4.5	0.5 M	1.0 M	2.5-3.5	0.1 M		Rem.	0.3 M		For certain castings of such design as might prove difficult casting job in Al-Cu alloys and where mechanical properties somewhat in excess of those of Al-Si alloys are required.
Aluminum-magnesium alloy (sand cast)		0.1 M	0.05 M	0.4 M	0.3 M	3.2-4.3		Rem.	0.6 M	0.2 M	Used for dairy equipment, pipe fittings, carburator cases, sewage disposal equipment, small ornamental castings, and kitchen utensils.

(Continued on page 1349)

NO BABBITT SHORTAGE HERE!



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Relieves The Shortage of Tin-Base Babbitts

The Battelle Memorial Institute has authorized us to use their process for producing lead-base Babbitts with silver content. Although conceived to replace tin-base Babbitts, NBM SILVER is by no means a mere "substitute". It has relatively the same physical characteristics:

Retains hardness at high temperatures • Easy to handle and to bond • Resists squeezing-out at operating temperatures • Corrosion resistant.

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AMERICAN Brake Shoe COMPANY

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METALS REFERENCE BOOK

Engineering Data File Facts

LIGHT METAL CASTING ALLOYS

TYPE			PROPERTIES												
			Ten. str., p.s.i.	Yield point, p.s.i.	Elong., % in 2 in.	Brinell hardness	Specific gravity	Elec. cond., %	Therm. cond.	Mod. of elasticity, p.s.i.	Coeff. therm. exp.	Endurance limit, p.s.i.	Yd. str. in compression, p.s.i.	Shearing str., p.s.i.	Density, lb./in.³
Non-heat-treated aluminum-copper alloys (sand cast)		1	22,000	14,000	2.0	65[1]	2.83	37[4]	0.34[23]	10.3[22]	22.5[24]	8,000	14,000	20,000	0.102
		2	22,000	14,000	2.0	65[1]	2.83	32[4]	0.30[23]	10.3[22]	22[24]	8,000	14,000	20,000	0.102
		3	23,000	14,000	1.5	70[1]	2.85	30[4]	0.28[23]	10.3[22]	22[24]	9,000	17,000	20,000	0.103
		4	24,000	18,000	1.5	75[1]	2.92	36[4]	0.33[23]	10.3[22]	22[24]	10,000	20,000	20,000	0.105
Heat-treated aluminum-copper alloys (sand cast)	1	H.T. 1	31,000	16,000	8.5	65[1]	2.77	35[4]	0.33[23]	10.3[22]	23[24]	6,000	16,000	24,000	0.100
		H.T. 2	36,000	22,000	5.0	80[1]	2.77	36[4]	0.33[23]	10.3[22]	23[24]	6,500	25,000	30,000	0.100
		H.T. 3	40,000	31,000	2.0	95[1]	2.77	37[4]	0.34[23]	10.3[22]	23[24]	7,000	38,000	31,000	0.100
	2	H.T. 1	32,000	28,000	0.5	85[1]	2.73	36[4]	0.33[23]	10.3[22]	22.5[24]	8,000	34,000	27,000	0.099
		H.T. 2	37,000	32,000	0.5	100[1]	2.73	37[4]	0.35[23]	10.3[23]	22.5[24]	8,000	47,000	32,000	0.099
	3	H.T. 1	25,000	20,000	1.0	75[1]	2.85	41[4]	0.38[23]	10.3[23]	22[24]	9,500	20,000	21,000	0.103
		H.T. 2	36,000	30,000	1.0	100[1]	2.85	33[4]	0.31[23]	10.3[23]	22[24]		43,000	29,500	0.103
Non-heat-treated aluminum-silicon alloys (sand cast)		1	19,000	9,000	6.0	40[1]	2.66	37[4]	0.34[23]	10.3[22]	22[24]	6,500	12,000	14,000	0.096
		2	26,000	11,000	8.0	50[1]	2.65	40[4]	0.37[23]	10.3[22]	20[24]	6,000	11,000	18,000	0.095
Heat-treatable aluminum-silicon alloys (sand cast)	1	H.T. 1	30,000	20,000	5.0	60[1]	2.67	35[4]	0.33[23]	10.3[22]	22[24]		23,000	28,000	0.097
		H.T. 2	35,000	25,000	3.5	80[1]	2.67	36[4]	0.33[23]	10.3[22]	22[24]	7,000	29,000	30,000	0.097
		H.T. 3	28,000	23,000	1.5	60[1]	2.67	43[4]	0.40[23]	10.3[22]	22[24]	7,000	24,000	22,000	0.097
	2	H.T. 1	28,000	16,000	6.0	55[1]	2.63	39[4]	0.36[23]	10.3[22]	21.5[24]		18,000	22,000	0.095
		H.T. 2	32,000	22,000	4.0	70[1]	2.63	39[4]	0.36[23]	10.3[22]	21.5[24]	8,000	22,000	27,000	0.095
	3	H.T. 1	28,000	24,000	1.5	65[1]	2.71	32[4]	0.31[23]	10.3[22]	21.5[24]	8,000	24,000	22,000	0.098
		H.T. 2	35,000	21,000	2.0	60[1]	2.71	32[4]	0.31[23]	10.3[22]	21.5[24]	8,000	21,000	21,000	0.098
Magnesium-base alloys (sand cast)	1	H.T.	13,000	12,000	8	52	1.81								
		H.T.A.	34,000	19,000	0.5	69									
	2	H.T.A.	29,000	22,000	2	78	1.81								
	3	S.C.	27,000	12,000	5	50	1.83								
		H.T.	38,000	12,000	11	51									
		H.T.A.	38,000	19,000	5	62									
	4	H.T.A.	36,000	22,000	1	77	1.82								
Aluminum-copper-silicon alloy (sand cast)			21,000	14,000	2.0	55[1]	2.76	31[4]	0.29[23]	10.3[22]	22[24]	8,500	14,000	20,000	0.099
Aluminum-magnesium alloy (sand cast)			25,000	12,000	9.0	50[1]	2.64	35[4]	0.32[23]	10.3[22]	24[24]	5,500	12,000	20,000	0.095

Compiled by N. F. Hindle, Asst. Secretary, American Foundrymen's Association.

This table will also appear in a forthcoming book by Herbert Chase on designing for quantity production.

Make it with TUBING

The pressure under which American industry is working to keep abreast of the demands for war materials has emphasized the need for time, labor and cost saving in mechanical operations. Babcock & Wilcox Seamless and Welded Steel Tubing has aided this economy by its ready adaptation to a wide variety of parts and structural uses.

B&W Seamless or Welded Tubing can be used as machining stock for hundreds of small parts formerly processed from solid stock. Time spent in re-tooling your equipment will quickly be made up in increased production at low cost.

B&W TUBING IS MADE IN A VARIETY OF TESTED STEELS. AMONG THEM ARE:

- Carbon Steels
- Carbon Molybdenum
- B&W Croloys
- S.A.E. Alloys
- High-Strength Alloys
- Stainless and Corrosion-Resisting Alloy Steel

SEAMLESS

B&W Seamless Tubing is made in a complete range of carbon and alloy steels and in sizes from ½ in. to 8⅝ in., O. D.

WELDED

B&W Resistance Welded Tubing is produced in carbon grades in sizes ranging from ¾ in. to 4 in., O. D.

THE BABCOCK & WILCOX TUBE CO.

SEAMLESS TUBE DIVISION
BEAVER FALLS, PA.

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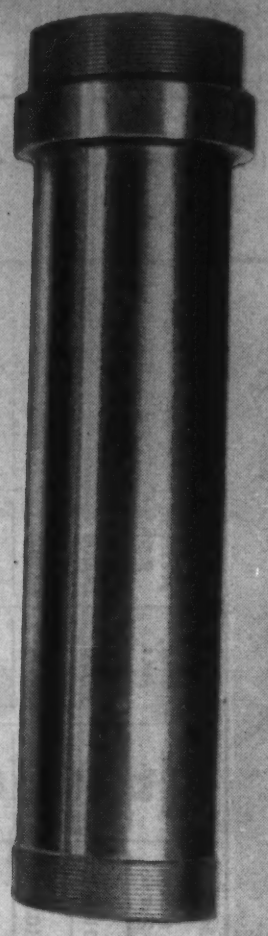
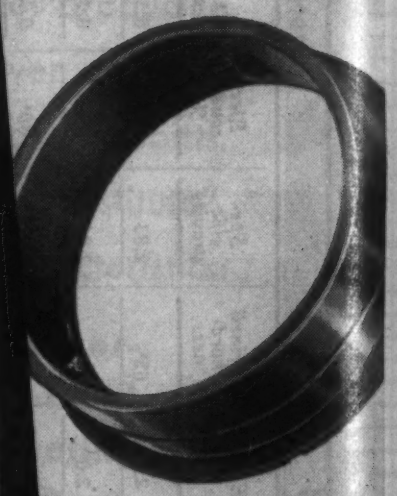
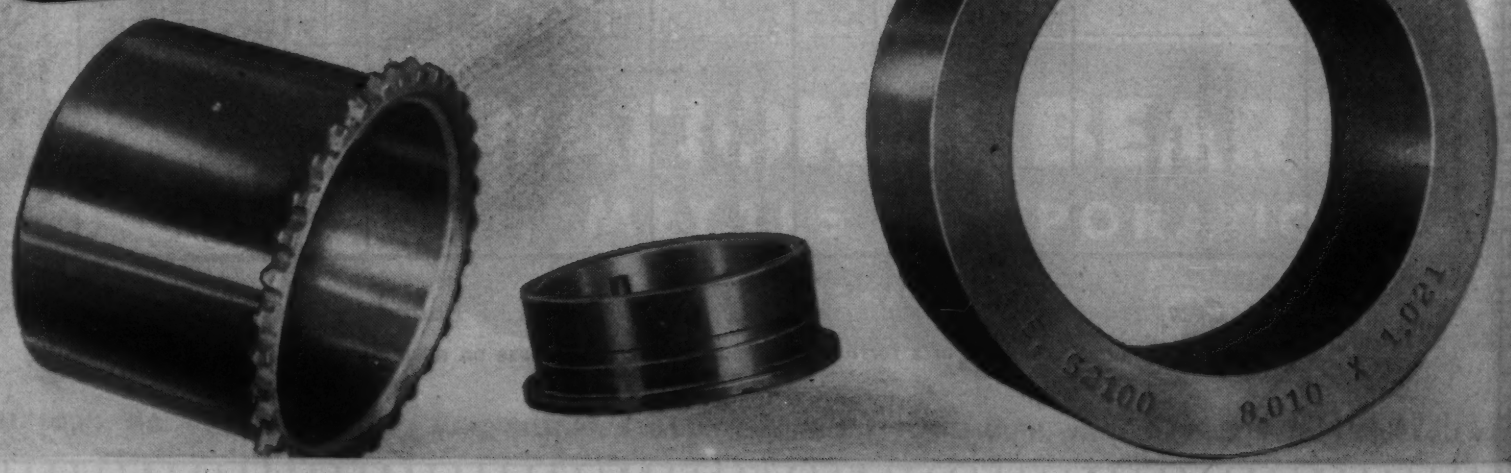
TA-1268







METALS and ALLOYS

Engineering File Facts

NUMBER 32
December, 1943

MATERIALS AND DESIGN
Plastics

Plastics Forming Methods

One of the most widely discussed design materials in the non-metallics field is that group known as the plastics. These interesting chemical compounds offer such combinations of properties as resistance to chemical attack, light weight, electrical non-conductance, moldability, insolubility in water, and attractive appearance. They usually have definite limitations, too, including low strength, cold flow, brittleness, and poor heat resistance, when compared to metals.

The group divides naturally into the thermosetting materials, which, once formed, cannot again be softened by heat, and the thermoplastic types, which can be softened by heat and remolded. The former types, when exposed to temperatures in the neighborhood of 400 to 500 deg. F., char and are destroyed without fusing, while the thermoplastic synthetics can be repeatedly softened by temperatures somewhat lower — some, in fact, below the boiling point of water.

Methods of molding are determined by the requirements of the work, which dictate the type of plastic to be used and kind of filler, if any.

Methods of Molding

Compression molding — This process is used especially for the thermosetting resins. It is the most widely used method of fabrication for plastics. The material, in a partially reacted form, is supplied to the press as a pellet or in a predetermined amount of powder. An excess of 3 to 10 per cent is usually supplied to insure complete filling of the form. Heat and pressure are applied for a definite time, after which the piece is removed, the flash is trimmed off, and any necessary polishing done.

Injection molding — Thermoplastic resins are most commonly used. The material is heated to a plastic state in a separate container, and this viscous liquid is then forced into a cold mold. It becomes firm in a few seconds, and may be removed from the mold.

Transfer molding — A process analogous to injection molding, but used for the thermosetting phenolics. The material is heated in a preheating chamber until it becomes sufficiently plastic to be forced into the mold. The curing period necessary with resins of this type is greatly shortened by the preheating of the material.

While the operation usually requires skilled operators, automatic presses have recently been produced for this work. The process produces accurately sized pieces which may be of complicated form.

Extrusion — Most thermoplastic materials may be extruded. The process consists of squeezing the semi-liquid material through a die, and carrying the extruded form into a cooling tunnel or under air jets. The process requires considerable skill and experience, especially in designing the die. The die opening may not resemble the finished form very closely. A considerable number of variables, such as the moisture content of the powder, grain size, temperature in the heating chamber or nozzle, or method of cooling may greatly affect the results obtained.

In the standard type of apparatus a hopper feeds the powder to a drying chamber, from which it is passed to the extruding machine. A heating chamber first brings the material to the desired temperature, and a screw press forces it through the extrusion die. A belt conveyor, usually designed especially to give support to the still-plastic material, next carries it under air nozzles, which chill it as quickly as the work will permit.

Casting — This is probably the simplest form of fabricating. It is used for a limited group of the synthetics, usually of the phenol type. The material is poured into lead molds, and requires a protracted curing period of from 3 to 12 days. Considerable hand finishing is usually necessary.

Cold molding — One of the oldest types of fabrication, cold molding, is limited to special compounds of synthetic and natural resins and gums with filler added. The filler is ordinarily a mineral, such as asbestos. The mixture is pressed into cold steel molds and then cured by a carefully controlled baking treatment. A wide variety of properties may be given the finished material by varying the composition. Binders may be pitch, asphalt, shellac, sodium silicate or Portland cement; fillers include asbestos, iron oxide, slate, and clay.

Blow molding — When hollow shapes are required of such form that they cannot be made by the die and press plunger, blow molding may be useful. In this method sheets of thermoplastic material are placed between halves of heated molds and blown into the mold form by steam or heated air. The process resembles the blowing of glass into molds. After cooling the piece is removed and the fins trimmed away.

Other Forms

Laminating — To overcome the limitations of the ordinary molded or cast plastics, a reinforcing web of cloth, paper, asbestos, or woven glass may be combined with the resin. Resistance to impact and other strength characteristics are improved, and tendency to cold flow is decreased. By selection of the type of laminating material and varying proportions of plastic and filler, a control of properties can be exercised.

As the use of the laminating material reduces the transparency and attractive appearance of the finished product while increasing its strength, these resins are used principally as materials of construction.

The laminating material is dipped into a solution of the resin in a suitable solvent, then run through rollers to squeeze out the excess solution. The remaining solvent is evaporated in a drier, and the resin is simultaneously converted to an intermediate form in which it is insoluble and semi-fusible. Finishing consists of forming the material to the desired shape and completing the reaction by applying heat and pressure. Tubes or rods may be made by rolling the cloth on a mandrel and molding to shape, or by baking in an oven.

The paper or cloth may also be used in a macerated condition, being chopped up after impregnating with the resin. This material can be molded similarly to the raw materials for other plastic types. The resulting product shows a higher strength than the unlaminated plastics.

Calendering — Another method of impregnating cloth with plastics is calendering. The resins used may be cellulose derivatives, such as nitrocellulose; vinyl polymers and copolymers; modified alkyds, and varnishes. The material may be applied to the cloth by rolling on in warm molten condition, by brushing, or by dipping in tanks. The coated material may then be cooled, in the case of the thermoplastics, or baked if the thermosetting type resins have been used.

In a later "Engineering File Facts" the physical and chemical properties of the types of plastics will be tabulated and generalized.

To the Seven Men in Eight who Never Need Anything but "Average" SPRINGS

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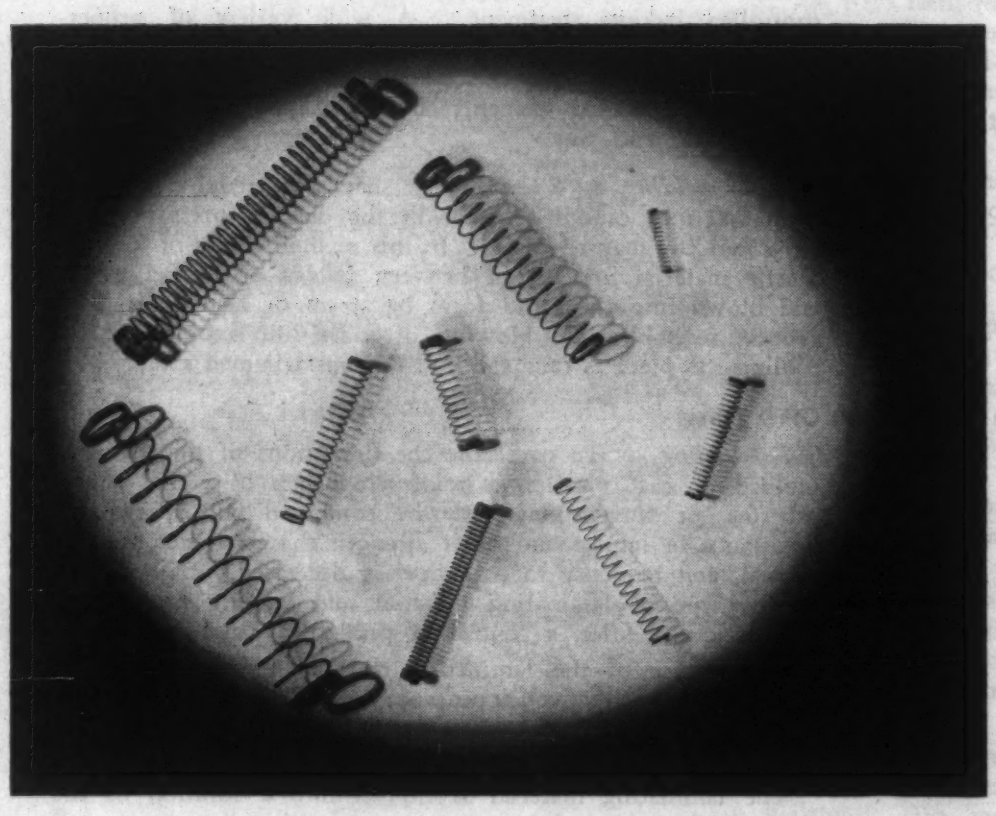

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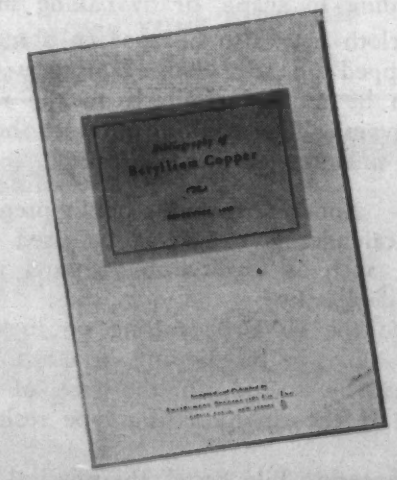

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INSTRUMENT SPECIALTIES CO., INC.

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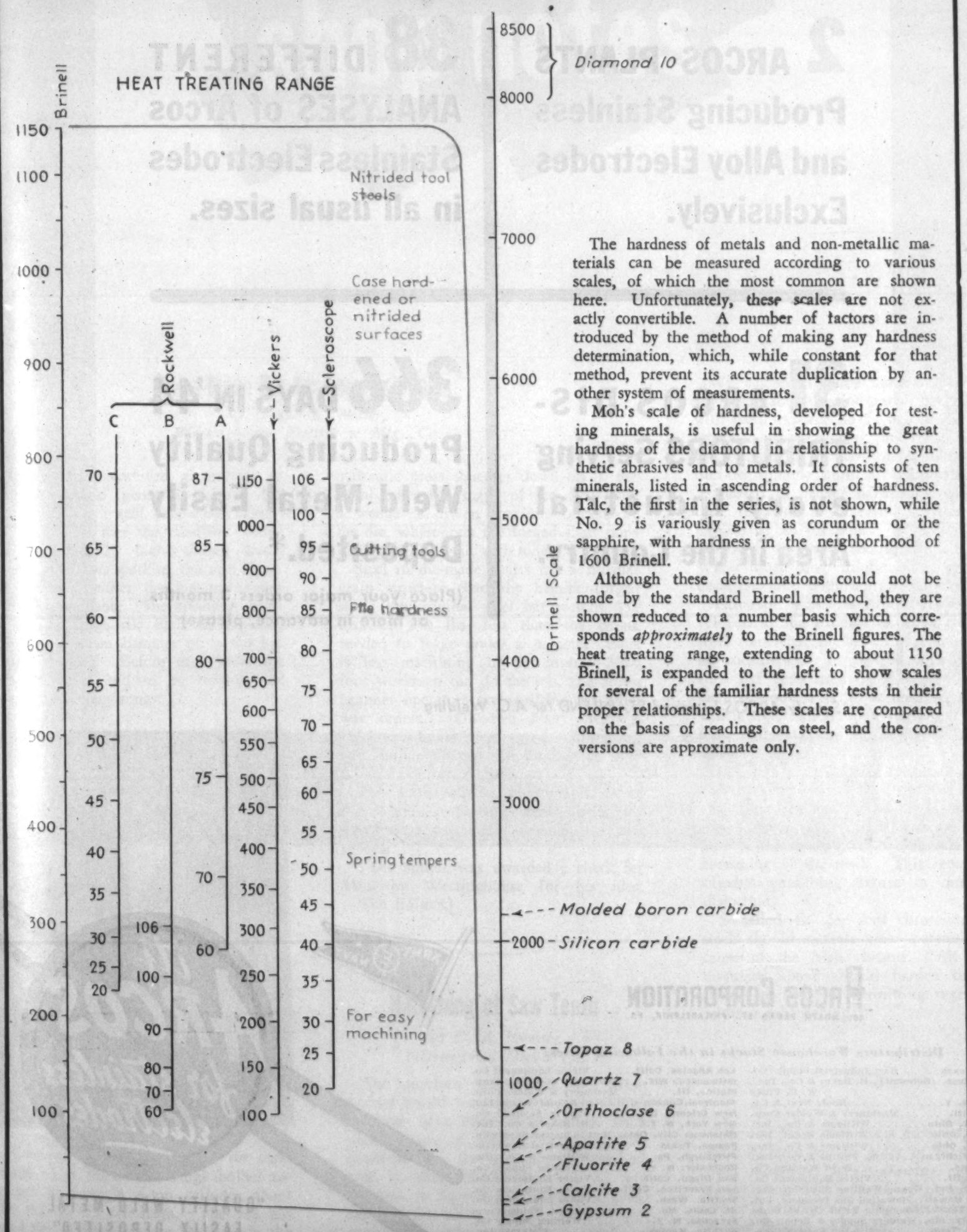
METALS and ALLOYS

Engineering File Facts

NUMBER 33
December, 1943

GENERAL ENGINEERING DATA

Hardness Scales



The hardness of metals and non-metallic materials can be measured according to various scales, of which the most common are shown here. Unfortunately, these scales are not exactly convertible. A number of factors are introduced by the method of making any hardness determination, which, while constant for that method, prevent its accurate duplication by another system of measurements.

Moh's scale of hardness, developed for testing minerals, is useful in showing the great hardness of the diamond in relationship to synthetic abrasives and to metals. It consists of ten minerals, listed in ascending order of hardness. Talc, the first in the series, is not shown, while No. 9 is variously given as corundum or the sapphire, with hardness in the neighborhood of 1600 Brinell.

Although these determinations could not be made by the standard Brinell method, they are shown reduced to a number basis which corresponds *approximately* to the Brinell figures. The heat treating range, extending to about 1150 Brinell, is expanded to the left to show scales for several of the familiar hardness tests in their proper relationships. These scales are compared on the basis of readings on steel, and the conversions are approximate only.

Compiled by Kenneth Rose, Engineering Editor

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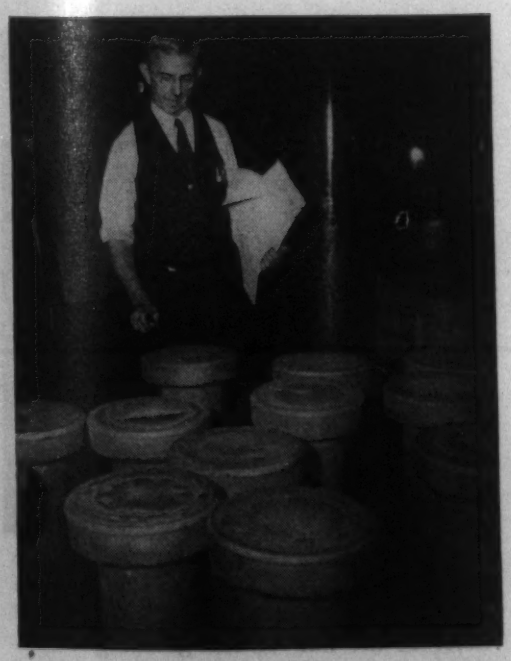
METALLURGICAL ENGINEERING shop notes

Home-Made Die for Forging Shafts

by Joseph K. Miller,
Westinghouse Electric & Mfg. Co.

Our company received a contract to produce electric generator shafts for Navy ships on a stiff production schedule. To have met the deadline would have required 20 highly-skilled steam hammer operators working day and night, but we had neither the manpower nor machinery available. The orthodox method was to forge the shaft by repeated blows of a steam hammer on a red hot chunk of steel. Before each blow the block of steel had to be twisted and turned with long tongs.



Consequently, we designed a die composed of 6 thick steel rings bolted together to form a 6-ton cylinder about the size of an oil drum. The red hot steel bar is dropped into the hole in the center of the pile and when a 1000-ton hydraulic press squeezes down on it, the metal takes the shape of the die. Then a wedge is driven into the bottom of the die, whereupon the forged shaft pops up and is lifted out with tongs.

Steel in die-made shafts has a sturdier grain structure than the hammer-forged steel; the original steel bar weighs 351 lbs., or 130 lbs. less than the chunk needed to forge under a hammer; there is less machining to be done. Now four workmen can do the job, and steam hammer operators are available for other war orders. On two Navy contracts 2533 man-hours were saved. Moreover, with minor changes the die can be used to turn out other shafts.

The accompanying photograph shows the author inspecting some shafts for Navy vessel generators made by the new process.

[The author was awarded a check for $500 by Westinghouse for his idea. —The Editors]

Hardening of Saw Teeth

by D. A. Nemser
International Nickel Co.

The question was asked us: "What method would you suggest to fully harden the teeth of a 36-in. diam., ¼-in. thick circular saw, of SAE 3150 nickel-chromium steel? The saws are hardened all over to about Rockwell 35-40 C, and we wish to superimpose additional hardness on the teeth only to obtain maximum wear resistance without sacrificing toughness in the other parts of the saw."

We suggested flame hardening. The saw blank should be mounted in a fixture with teeth exposed so as to prevent distortion during heating and quenching. By rotation of the saw blank with relation to suitable burners, the teeth may be heated to proper hardening temperature, followed by emersion of saw and fixtures in an oil tank. A hardness of Rockwell 50-55 C should be attained. Water quenching might attain greater hardness, but with danger of cracking.

However, wear resistance will be developed at the expense of toughness. A steel somewhat higher in carbon should be considered. In fact, a 0.70 carbon steel has been used by makers of large circular wood saws for some time, a steel which should develop a minimum hardness in the teeth of Rockwell 60 C after flame hardening. It may be necessary to draw back to get correct toughness.

Of course, flame hardening is tricky and might best be done by outside specialists. Again, you might increase hardness of the entire saw to eliminate flame hardening of the teeth. This requires a suitable quenching fixture to minimize distortion.

So-called 4-6 per cent chromium tool steels should increase wear materially because of the high chrome. All steels discussed above should harden through the ¼-in. sections, permitting regrinding without rehardening.

At one plant they use a pictorial record book of each job in place of blueprints. This eliminates large drawings and replaces them with a book of sketch operations showing only the dimensions included in each operation.

—Informative Technical Bulletin, No. 10, War Production Board

Counting Nuts by Ratio Balancing

by Frank Webb,
Buick Motor Div., General Motors Corp.

Here is another one of those very simple ideas for the shop — but the simplest is usually the best. Mrs. Nettie Rowe is an expert in making angel food cake in her own home in civilian life, her secret being the exact and correct proportions of the flour, eggs, sugar, etc.

But, in this photograph, Mrs. Rowe is actually weigh-counting aircraft engine cylinder hold-down nuts in a Buick plant, building Consolidated B-24 Liberator bomber engines. Three nuts have been placed in the small left-hand pan, and the weights have been adjusted for a ratio of 1 to 100. Consequently, there will have to be placed in the large right-hand pan 300 nuts to force a balance. Certainly this is more rapid than for Mrs. Rowe to count the nuts by hand.

We imagine today's school teacher is asking the arithmetic class: "Now, if Johnnie places three apples in the left hand pan, and the scales are set at 1 to 100 —."

Correct Speed for Metallizing

by A. P. Sheperd,
Metallizing Engineers Co., Inc.

Probably more than half of all metallizing guns in use today are operated at uneconomically low speeds. Modern equipment is designed to spray at high speed. When the wire is fed through the flame too slowly, atomization becomes finer and percentage of oxide in the coating increases. If the average diameter of the sprayed particles is reduced to one half normal, total surface area, hence total oxide, is multiplied by four.

Most metals vaporize somewhat in an oxyacetylene flame, this being intensified by slowness. Thus, many particles are not deposited on the work but are carried away by the blast from the gun.

Moreover, excessive oxide makes such coatings very difficult to machine. Hard rings, which form adjacent to the shoulder of the undercut section, consist largely of oxides, and these are thicker when speed is low. The tensile strength of the deposit is also lowered by slowness.

Extremely fine coatings, the pores of which are largely filled with oxides, will not absorb as much oil as a normal coating, hence will not resist wear as well. Slowness can cause fusing of the wire at the end of the nozzle, resulting in frequent nozzle replacements.

In adjusting the gun for maximum speed, the best procedure is as follows:

(a) Set regulators at desired pressures and light the gun in the usual manner.

(b) Slowly increase the speed of the wire until the gun is spattering rather than atomizing.

(c) Slowly raise and lower the oxygen pressure while watching the melting end of the wire. Attempt, by changing pressure, to secure good atomization, which will result in the wire melting back closer to the end of the air cap.

(d) If, after adjusting the oxygen, the wire is still spattering, slow the wire feed only to the point where spattering ceases. On the other hand, if the oxygen adjustment results in the wire melting back level with, or close to the end of the air cap, the wire feed should be speeded up to the spattering point and then slightly retarded as before.

The melting end of the wire should always project beyond the end of the brass air cap as far as possible. It should never be level with or inside the end of the air cap.

While spraying, attention should be paid to the flame and the melting end of the wire. If small blue streamers of flame appear, acetylene pressure has become too high. Oxygen pressure should then be raised slowly until the blue streamers disappear. If the flame becomes smaller, and the wire appears to speed up and run out of the flame, oxygen pressure is too high and should be lowered slowly until atomization is again normal. Do not slow the wire feed. Sudden speed-up is impossible with the Power Control Governor.

Tube Bends by Stamping and Welding

by Percy House,
Weber Showcase & Fixture Co., Inc.

A few months ago a very unusual bottleneck appeared in our shipbuilding program. Construction of cargo vessels called for the fabrication of hundreds of thousands of return pipe bends for steam pipes in deep oil tanks. After much research as to how these bends could be produced in the shortest possible time, we finally put into effect the following process.

We had a set of dies manufactured whereby a die stamping operation and a simple welding job sufficed and allowed us to start deliveries ahead of schedule. From large sheets of 3/16 in. steel plate pieces were cut to approximate the shape of the bedroom rubber hot water bag. These pieces were then placed in the bed of a die-stamping press, in which two operations were performed in one step.

One set of dies drew the plate to a partial tube closure, while another set completed the closure. Two of these units were then chamfered and welded together, end to end, to form the completed return bend, the diameter of the tubing being about 1½ in.

Cast iron pots give longer service if given a good "weather curing." Leave them out in the rain or snow, cold and heat for about six months. Even a little rust is good for them. A new, "green" pot will retain a molecular action for several months. If this is not arrested before the pot is placed in service, cracking is apt to result.

—"Metal Minutes"
Stewart Industrial Furnace Div.,
Chicago Flexible Shaft Co.

Scrap Iron Grinding Wheel Lifter

by a Lycoming Div. Employee

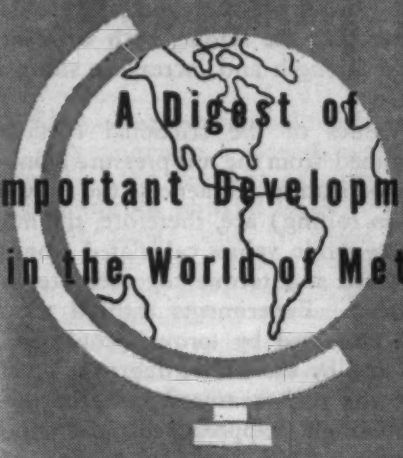
It formerly required two men to change a grinding wheel working on a Lycoming R-680 crankshaft. However, we contrived a Y-shaped wheel lifter of scrap iron, which allows the change to be made by one man.

A grinding wheel dressed to a given contour is used to produce certain of the radii between bearings on the crankshaft. To provide a relief and the radii of the two main bearings, a wheel dressed to a different contour is required. Because of the critical shortage of abrasives, redressing of the wheel for the latter operation was rejected in favor of replacing it with a second wheel specially dressed for the purpose.

Using the scrap iron lifter, two prongs of the "Y" bolt into the attachment holes at the hub of the grinding wheel. An eye is provided in the upper end of the lifter to facilitate picking up the hook on the chain block.

The device is so shaped that the grinding wheel suspends vertically when raised from the floor, and the operator is able to slip it into place on the spindle of his machine without additional help.

Metallurgical Engineering Digest



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1 Metal Production

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Hot and Cold Rolling of Metals

Condensed from

"Zeitschrift für Metallkunde"

A series of large scale rolling tests involving high precision measurements of torque and roll pressure as well as extensive mathematical treatment of the results was carried out, principally on non-ferrous alloys (electrolytic lead, 95% Al, 4% Cu-Al, 7% Mg-Al) but for comparison also on some alloy steels (0.2% C max.-15% Ni, 0.2% C max.-5% Al). The purpose was to give the practical rolling mill operators needed data on the hot and cold rolling of sheet and strip.

Cold Rolling

In cold rolling there is a close connection between the 0.2% yield strength, the roll pressure, and the torque, so the latter two values are fixed if the first is known. Tensile strength and Brinell hardness are unsuitable criteria of the behavior of the metal in rolling. Contrary to former ideas, the roll pressure is exerted radially and not perpendicularly to the surface of the work.

The divergence between the measured and calculated values of roll pressure and torque is due to the previously disregarded effect of external friction between the material and the rolls. It is virtually impossible to measure this friction directly because (1) it acts in both the direction of rolling and along the roll axis, (2) it is not consistent along the line of contact between the roll and the work, and (3) it does not act uniformly in the direction of rotation of the roll. Roll pressure increases considerably faster than the torque, both with increasing yield strength and increasing strain hardening.

Values of the frictional coefficient determined from the roll pressure alone (which predominantly influences the power take-off in rolling) are, therefore, the most inaccurate while values calculated from the roll pressure and torque together are the most reliable. Experiments showed the friction (as measured by torque) could be greatly reduced by the use of lubrication, in which case the real measured value of the torque increasingly approached the theoretical value.

On the assumption that lead is completely plastic (non-resilient), substantial elastic recovery was determined for the light alloys. Planned variations of friction, rolling speed and drafts indicated that the elastic recovery depends mainly on the thickness and mechanical properties of the material.

Although the roll pressure and torque increase with the rolling speed in both hot and cold rolling of light alloys, the increase is far less for cold rolling. Further, the torque is higher in hot than in cold rolling, while the reverse is true for the roll pressure. The ratios of aluminum to duraluminum are:

torque value—10-mm. initial thickness, 1:1.9
pressure value—10-mm. initial thickness, 1:2.2

In other words, the load on the driving motor increases less quickly with the hardness of the material being rolled than the load on the rolls and housing.

Hot Rolling

An alternative characteristic as reliable for hot rolling as the 0.2% yield strength is for cold rolling is lacking. The practice has been established of using "resistance to deformation" (deformation strength) in the mathematical treatment of hot working processes, but the application of identical values for pressing, rolling and forging may be the source of considerable error.

The deformation strength of metals in hot rolling is chiefly governed by (1) chemical composition, (2) working temperature, (3) draft, (4) initial thickness of stock, (5) effective diameter of the rolls, (6) friction in the pass, (7) rolling speed, and (8) ratio of the width of the stock to the compressed length. The rate of deformation has a marked effect on the deformation strength. For example, if the rate of deformation at 1000°C. (1830°F.) of mild steel is increased 70 times (*e.g.*, rolling

(Continued on page 1365)

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- **Rite-Sulphur Reducer**—put in ladle.

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instead of pressing), the deformation strength will nearly double, while an increase of 1200 times (*e.g.*, forging) will increase it 2½ times. In light alloys a considerable dependence is also found between the deformation strength in rolling, the thickness of the material, and the per cent draft. Hot tensile tests fail to take into account the decisive effect of friction. Upsetting tests likewise fail to furnish results directly applicable to rolling because of the great influence of rolling speed on deformation strength.

No form of continuous load upsetting can furnish any comparison for rolling. Mathematical analysis of the latter must depend entirely on the availability of sufficient reliable data from actual rolling tests.

The quality of the aluminum plating on aluminum-clad is best when using large roll diameters, high pressure in the pass, and low rolling speeds. This condition and the ensuing finishing of the rough stock in small rolls at high speed are contradictory but can be brought into agreement to some extent by using a d.c. drive and adjusting the rolling speed.

—O. Emicke & K. H. Lucas. *Zeitschrift für Metallkunde*, Vol. 34, Feb. 1942, pp. 25-38; translated in *Sheet Metal Inds.*, Vols. 17 and 18, Apr. to Sept. 1943 issues.

Open Hearth Lining Maintenance

Condensed from a Preprint, Iron and Steel Institute

Supplementary information to a paper on "The Lining of Large Basic Open-Hearth Tilting Furnace," Journal of the Iron & Steel Institute, Vol. 146, No. 2, 1942, pp. 9P-16P, this paper discusses the use of parging pastes containing chrome ore and serpentine, with the object of reducing the consumption of magnesite.

Since 1939 considerable effort has been made to reduce magnesite consumption, later to reduce the chrome ore as well as magnesite consumed, and finally to replace both of these materials by substitutes.

Points affecting the changes in consumption are (1) the percentage of chrome ore in the paste was increased and some magnesite saving resulted; (2) chrome ore percent was steadily reduced; (3) the front bank was fettled after the whole of the scrap, etc., was charged, but before the addition of the hot metal, enabling pasting to commence at higher level, but using more dolomite; (4) stable dolomite cement was used in place of magnesite powder for rebuilds; (5) water cooling of front lining was used earlier, but was abandoned at the end of 1942; and (6) more basic bricks were used in the splays and less patching paste was therefore necessary.

Laboratory tests showed that an 80-20 mixture of serpentine-magnesite best satisfied the requirements of refractoriness and economy of chrome ore and magnesite. Mixtures of chrome ore and serpentine were unsatisfactory.

The new paste was somewhat inferior to the material it replaced. Therefore, as the front of the furnace was continuous, steel

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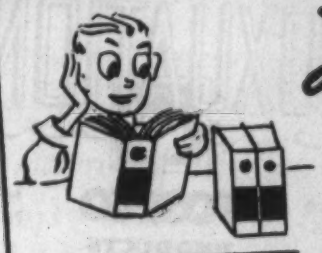

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plate shutdowns were frequent. To overcome this, structural work of the furnace was strengthened and openings were cut through the plate work between each door, which could be covered during operations. By this means new brickwork could be put into the lining without taking the furnace off.

Following is the grading of 80-20 serpentine-magnesite paste, with moisture 22.8%, British standard sieves: On 7 mesh, 1.0, 7-25 mesh, 27.0; 25-72 mesh, 29.0; 72-150 mesh, 12.5; and through 150 mesh, 30.5%.

—A. Jackson. Preprint, *Iron & Steel Institute*, Aug. 1943, 3 pp.

Nitrogen Control in Electric Furnaces

Condensed from "Stahl u. Eisen"

The nitrogen control was investigated in 102 melts in 3 different basic arc furnaces. It was observed that in the elimination of nitrogen, the principal determining factor was the rate of decarburization which predominated over the other factors, *viz.* the nature of the furnace atmosphere, the nitrogen concentration of the charge, the size of the ore and the distribution of carbon monoxide bubbles in the charge.

No generally applicable curve representing the elimination on nitrogen can be drawn owing to the many factors which affect the process. Some elucidation of the phenomena occurring in the elimination of nitrogen in the furnace by boiling was afforded by experiments on the degasification of water containing CO_2 through which air was blown.

The greatest absorption of nitrogen took place during carburization of the charge at an average rate of 0.0013 per cent nitrogen per hr. During refining the nitrogen pick-up is small and depends on neither initial nitrogen content of the melt, furnace atmosphere nor alloying elements present. The increase of nitrogen in the charge if the content of alloying elements increases is due to the high nitrogen contents of these alloying metals.

Nitrogen take-up during tapping is not uniform, nor is it quantitatively related to the nature of the alloy steel.

—W. Altpeter, *Stahl u. Eisen*, Vol. 62, Nov. 26, 1942, pp. 997-1001; abstracted in *Iron & Coal Trades Review*, Vol. 146, June 11, 1943, p. 893.

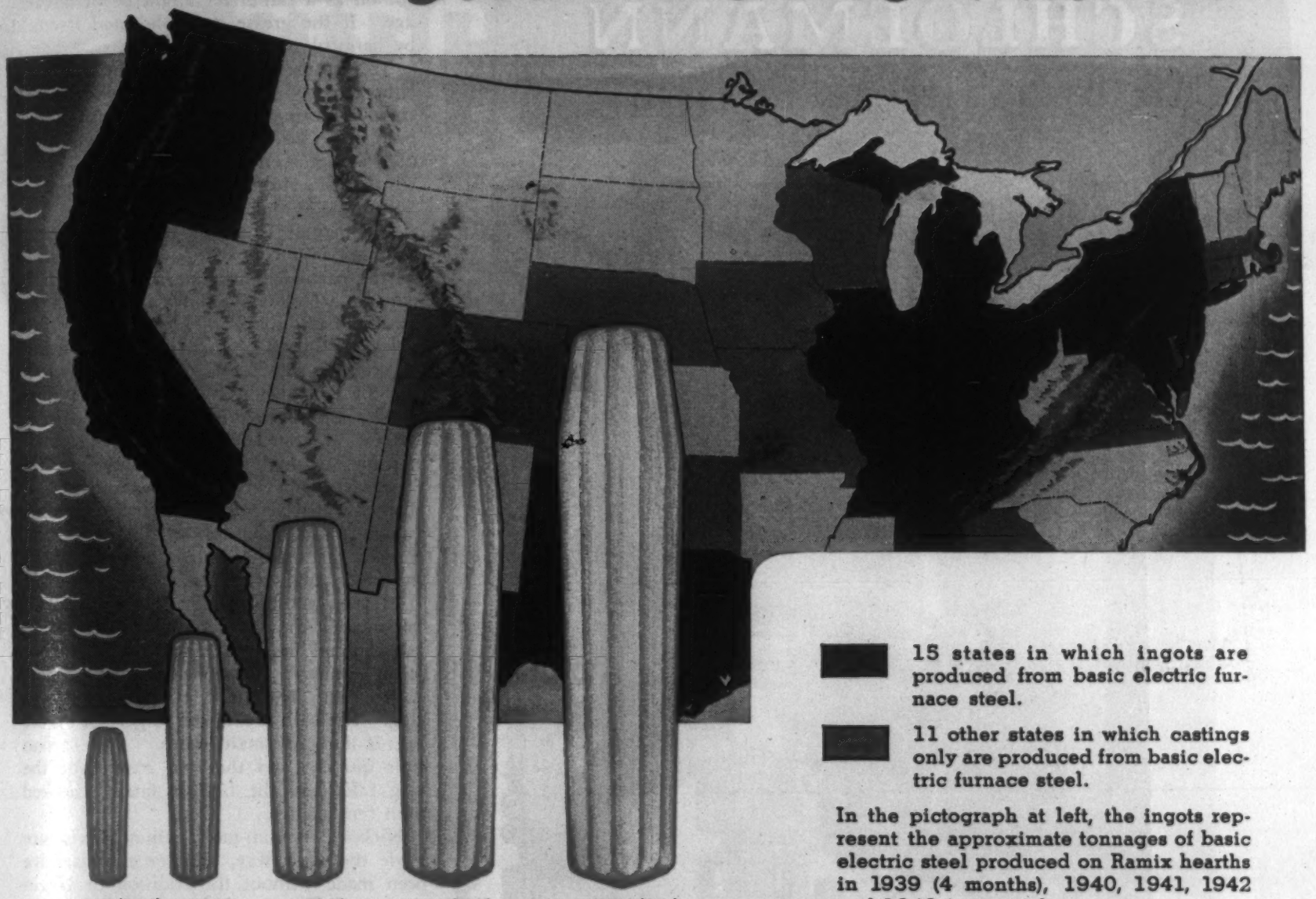
Utilization of Alloy Steel Scrap

Condensed from "Iron and Steel"

Alloy steel scrap can be bought as turning or swarf. The objectionable features are low density; grease, perhaps sulphonated; and doubtful composition. The density of scrap is often expressed as a grade number, which is the weight in hundredweights of 1 cu. yd.

Greasy turnings are undesirable for elec-

Wherever Electric Steel is made...



15 states in which ingots are produced from basic electric furnace steel.

11 other states in which castings only are produced from basic electric furnace steel.

In the pictograph at left, the ingots represent the approximate tonnages of basic electric steel produced on Ramix hearths in 1939 (4 months), 1940, 1941, 1942 and 1943 (estimated).

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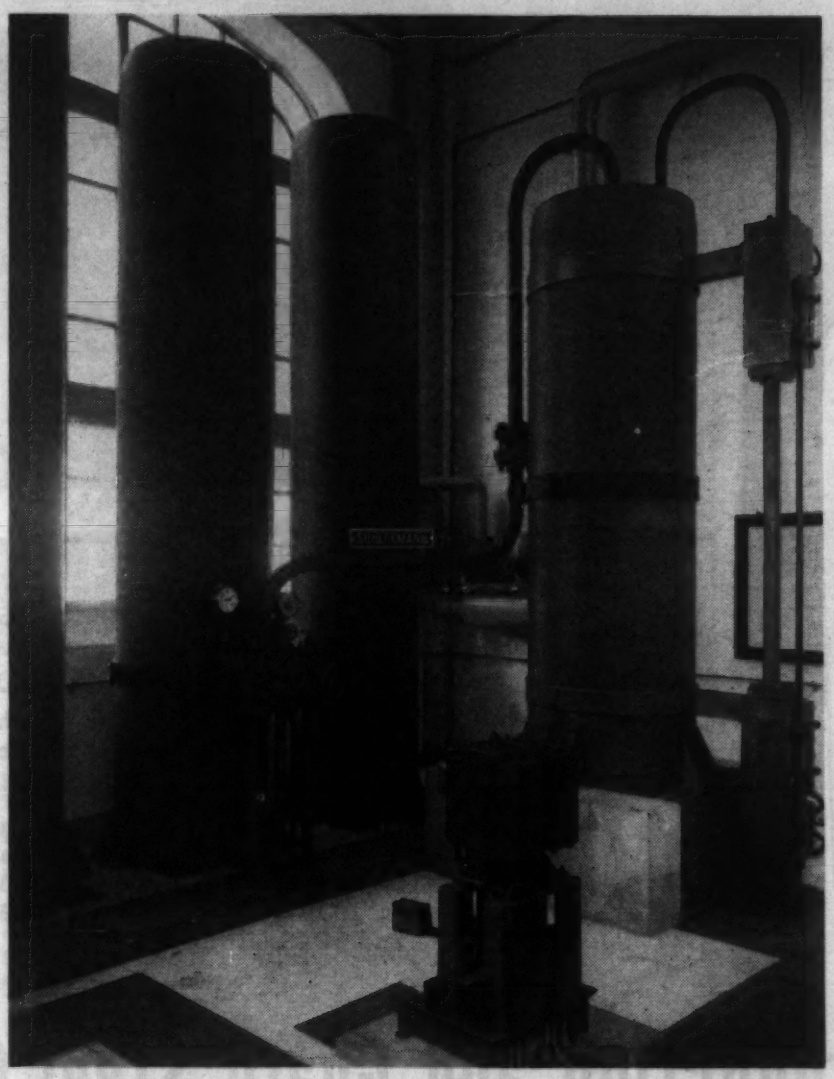

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tric furnaces because there is no flue to remove the vapors. This does not apply to turnings charged into open-hearth furnaces, for oil as a carburizer might be of advantage. If the grease is sulphonated it could be harmful in acid furnace heats.

To increase the density of light scrap it is either crushed or chipped. Crushing is all right if turnings are brittle, but chipping is preferred. Nickel-chromium steel turnings of 2-6 grade are converted to grade 30 chips, whereas nickel case hardening steel turnings do not grade higher than 18.

Whether it is worth while to separate turnings into composition classes depends on the particular machine shop. It can be done on a large scale, but it is not advisable for the small shop.

Pre-melting is favored today as a means of utilizing mixed alloy steel turnings. In the S.P.B. (Sheffield Process Basic) steel process, the practice is the same that is used for making one-slag heats in the electric, crucible, or high-frequency furnace. The charge contains all the alloys required to give the analysis called for by the specification, plus the usual margin of carbon. The charge should contain 0.5% Si and a maximum amount of Mn.

Melting and slag difficulties are not experienced if the chromium-bearing materials are charged first and covered with carbon steel turnings, limestone and iron being added last. The melted charge has a thin slag. The bath is allowed to get hot before ore is fed in small doses. The carbon falls quickly, and the iron content of the slag falls and the boil is finally checked with ferrosilicon.

Nickel-chromium-molybdenum steels are made the same way, and some heats have been made without the addition of virgin chromium. Experience shows that this modification of basic open-hearth working is a good medium for recovering alloys from scrap, particularly chromium.

In open-hearth furnaces where pig is normally used, much can be done to save alloys by carburizing to some extent with charcoal, anthracite or pitch carbon.

—H. Bull, *Iron and Steel*, Vol. 16, June 1943, pp. 432-437.

Increasing Open-Hearth Output

Condensed from "Stahl u. Eisen"

In consideration of the fact that the principal cooling losses of an open-hearth furnace occur during charging, and that false air sucked in through the openings of the furnace cool the air and gas chambers differently and disturb the thermal balance, means for remedying this condition were investigated. This disadvantage is particularly felt in furnaces the capacities of which have been increased by carburizing the gas where it was not possible to increase the combustion chambers. It is overcome by the additional heating of the combustion chamber, based on the idea of avoiding the entry of false air during charging and consequent cooling of the upper furnace. The object is to bring the chamber to its high-

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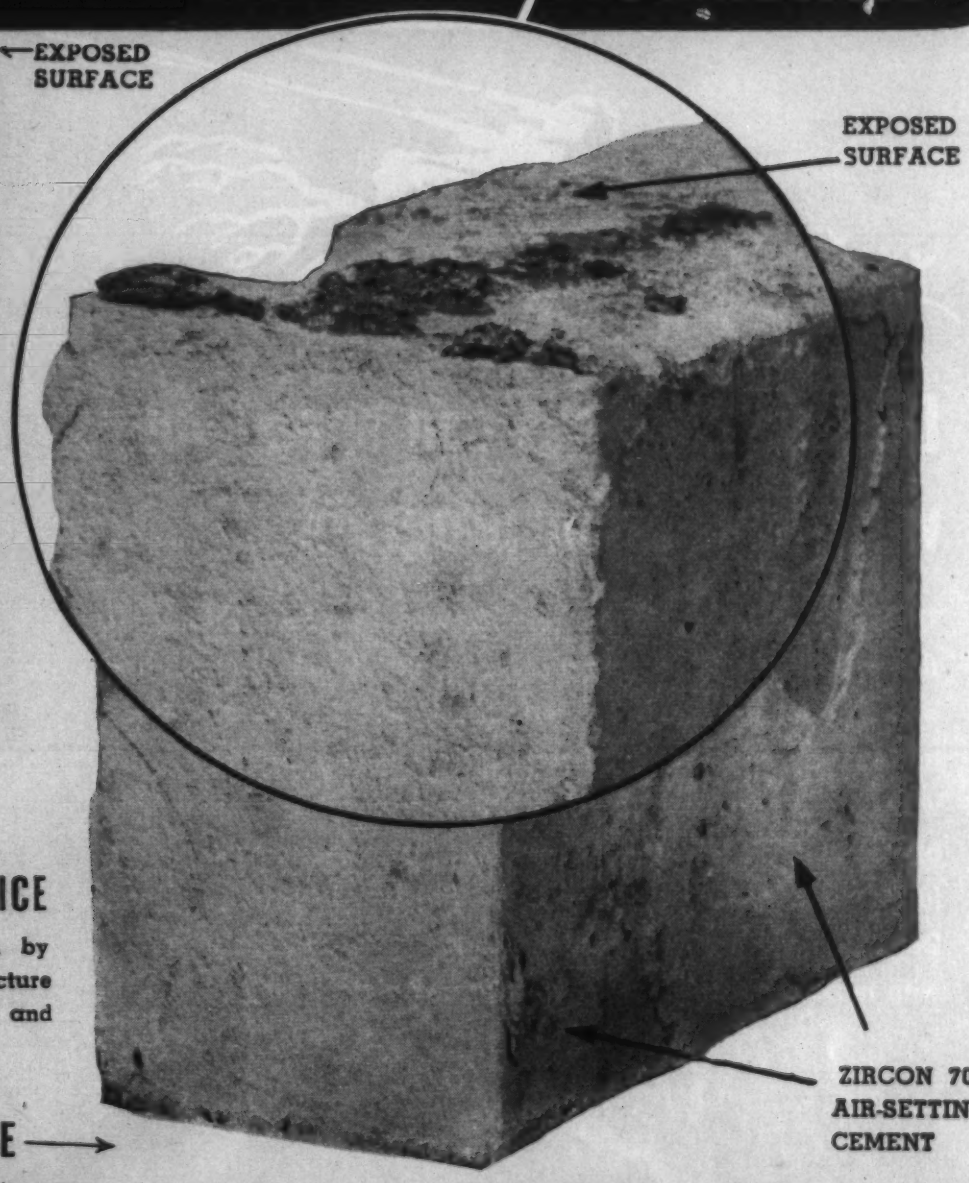
Section thru TAYLOR ZIRCON BRICK removed from hearth of aluminum re-melt furnace. 14,750,000 lbs. melted on this hearth. No penetration.



We think that these illustrations prove conclusively that, if the Refractory Industry ever developed a product which is unequalled, even uniquely fitted for one particular job, TAYLOR ZIRCON is certainly that product, when used for hearth construction in reverberatory type furnace for melting Aluminum.

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Heats and temperatures	With additional burners	Without burners
Heat consumption kg. cal./m.² hr.	334.5	277.3
Capacity of hearth area in melting, kg./m.² hr.	365	305
Chamber temperature, deg. C.	1100-1200	950-1000
Preheating temperature, deg. C.	1050-1200	900-980
Waste gas temperatures: a) charging deg. C.	1140-1250	1100-1220
b) melting deg. C.	1180-1290	1140-1250
c) finishing deg. C.	1340-1420	1140-1230
Bath temperature, deg. C.	1650-1750	1610-1670
Waste gas temperature, deg. C.	650-750	500-600

est temperatures during charging, and thus to increase the thermal efficiency of the checkers.

In the experimental furnace, eight burners were installed before the head of the air and gas chambers above the checker system and supplied with coke oven gas, and a recuperator was inserted in the waste gas channel between forter valve and flue. The additional burners are burning during charging at the outgoing end and operated by compressed air. During a 3-weeks trial, the capacity increased from 8.6 ton per hr. to 10 ton per hr. with cold charging. For the same charging time and same melting schedule, the melting time was shortened one hour, corresponding to an increase in capacity of 1.4 tons per hr. or 16.3 per cent.

Over a full furnace campaign, the average capacity of 7.86 tons per hr. of the normally operated furnace rose to 9.45 tons per hr. with additional heating, which is an increase of 20.1 per cent against the 16.3 per cent of the three weeks trial. The burning away of carbon was reduced to such an extent that for a charge of 62 tons 500 kg. (1000 lbs.) lime and 0.85 kg. (2 lbs.) pure manganese per ton could be saved.

The increased chamber temperature makes the use of high refractory bricks necessary. Chrome-magnesite bricks were used for the roof, and after 268 melts the furnace had to be closed down only for a minor repair of the furnace heads. This type of additional heating is particularly advantageous for open-hearth furnaces where the chambers are too small. The following tables illustrate the results of the tests:

The efficiency can further be improved by utilizing the waste gas temperatures for waste heat boilers, which permit to recover about 50 per cent of the heat, assuming that 1000 kg. cal. are required for one kg. steam.

—F. Engels & G. Prieur, *Stahl u. Eisen*, Vol. 63, Feb. 25, 1943, pp. 145-150.

Non-Ferrous Blast Furnaces

Condensed from "Engineering & Mining Journal"

There have been many changes in the size and proportions of non-ferrous blast furnaces in the past 40 to 50 years. However, nearly all the blast furnaces were and are constricted at the tuyere zone with an upwardly and outwardly flaring bosh. This creates a considerably wider furnace at the top, so that there is an increasingly expanding area from the tuyeres to the feed floor, which causes the charge to descend very slowly and the velocity of the ascending gases to be progressively diminished.

The bosh offers resistance to the downward movement of the charge, and increases the frictional resistance to the center core. The skewbacks are just where the charge is semi-fused so it can easily form protrusions, which restrict the opening.

The desirable features of an ideal blast furnace would be (1) a shape that would discourage the formation of shelves, arches and accretions; (2) wider at the tuyeres;

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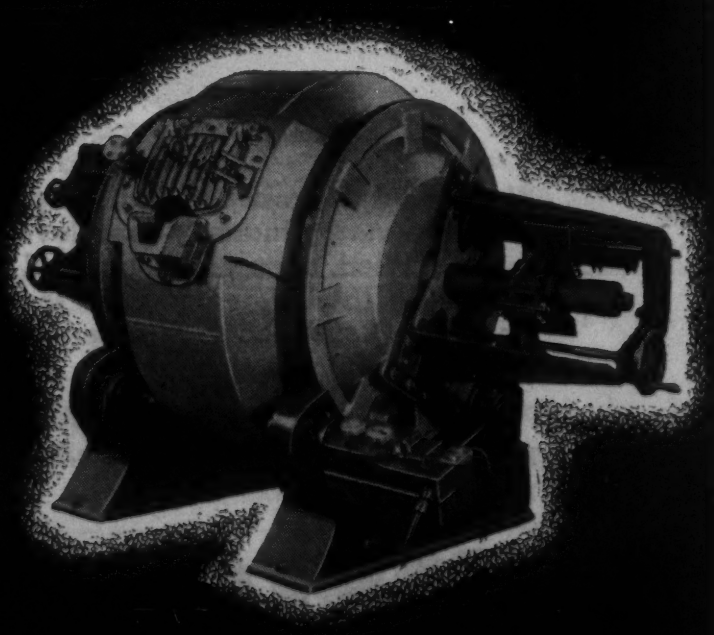

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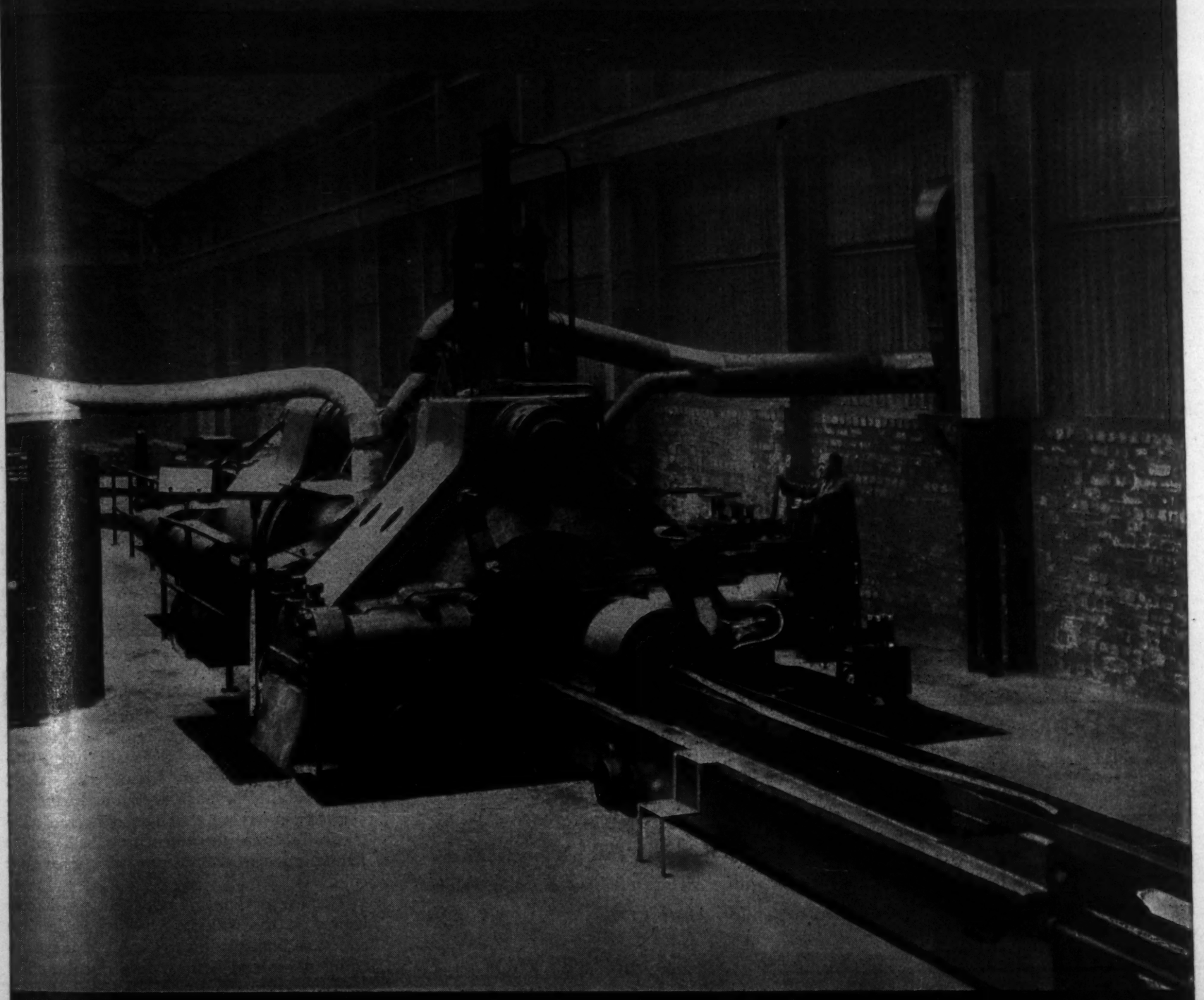

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(3) a large reserve of coke at the tuyeres; (4) large volume of air of sufficiently high pressure distributed evenly to give a deep penetration of the blast, a hot localized smelting zone and a high carbon monoxide concentration; (5) a smelting zone confined to the lower part; (6) a large space for storing slag for a sufficient time to permit settling of the metal and matte particles; (7) a non-slagging tuyere design; (8) a high velocity of gases in the shaft to remove excess fines and minimize the condensation of volatiles; (9) rapid subsidence of the charge in the shaft; (10) a short shaft; and (11) a small shaft area to prevent segregation of the charge.

A plan is given of an unconventional design that meets all of the above requirements. The inverted bosh forms an enlarged and intensified smelting zone confined to the bottom of the furnace. The shaft area is small in relation to the area at the tuyere plane. The increased number of tuyeres are inclined downwardly.

The advantages include a much larger tuyere line to accommodate the larger number of tuyeres, which give a larger volume of air, better distribution and a large area of carbon monoxide concentration. The smelting jackets have no skewbacks but rather skewbacks in reverse.

This furnace would have a high melting rate. Likewise, there would be less heat dissipation by cooling water. The tuyeres are 2 in. in diam., and most of them are at right angles to the inclined jackets. The combination of inclined tuyeres and the inwardly sloping jackets prevent the tuyeres from slagging.

Although this description is purely speculative, the design overcomes many of the difficulties of present blast furnaces. The furnace would be cheaper and stronger than conventional blast furnaces.

—J. S. Stewart, *Eng. & Min. J.*, Vol. 144, July 1943, pp. 64-68.

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Mill Hardening

Condensed from "Mechanical World"

To conserve alloys and fuel and to get better mechanical properties, German steel works are hardening steel directly from the rolling mill. The rolling is done so the finish rolled steel is still above the critical temperature. The steel is transferred to a controlled soaking furnace for a short time to equalize the temperature, and then it is oil or water quenched. The subsequent tempering is carried out in separate furnaces on continuous production lines.

As the initial temperature at which rolling or forging starts is increased, the critical transformation rate is depressed so the hardening takes place at a lower temperature. Therefore, it is possible to quench the steel below the Ar_3 (but above the Ar_1) and still have no separation of free ferrite. The use of lower quenching temperatures permits normally oil hardening steels to be water quenched with a decrease in cost and an increase in effectiveness of hardening.

The equalizing furnace is necessary to get full hardening while avoiding cracking and distortion due to quenching from excessively high temperatures. This furnace is very economical as it is really just a thermal reservoir. With higher alloy steels, the possibility of cracking can be further decreased by having the bars delivered automatically from the quenching bath to the tempering furnace before they are quite cold.

The use of fine grained steel gives more leeway to the roller. Aluminum, titanium and vanadium all lower the minimum hardening range and help to iron out the effect of temperature variations as received from the mill.

To get a given combination of properties, the tempering temperature must be increased 30 to 40° C. (55 to 70° F.) from that used in conventional heat treatment. As compared with the usual heat treatment, this direct mill hardening generally increases the tensile strength and yield point with the most marked improvement in the impact strength.

This heat treating method is very flexible, gives better mechanical properties, conserves alloys and fuel and lowers costs. The main disadvantage is that the steel cannot be inspected for defects until after it has been heat treated.

—J. Winning. *Mech. World*, Vol. 114, Sept. 3, 1943, pp. 259-262.

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1 5/16" O. D., 2 1/2 seconds

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1 1/2" O. D., 1 1/2 seconds

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Raw Materials Supply in Grey Iron Foundries

Condensed from
"Foundry Trade Journal"

This paper is a report by the cast-iron sub-committee of the technical committee of the Institute of British Foundrymen. One of the most significant elements in cast iron from the point of view of its influence on soundness is phosphorus.

Phosphorus has also a marked influence on the mechanical properties of cast iron, generally lowering strength, and particularly in reducing impact resistance or toughness. Apart from meeting the high mechanical strength specifications, low-phosphorus irons find a use as a means for ensuring soundness, particularly in castings that are subjected to pressure tests after machining.

Several methods have been used quite successfully for the production of bomb body castings in green sand molds without the use of feeding heads. These may be cast either vertically with the tail up, vertically with the nose up, or on the flat. In nearly every case, however, this entails the use of cast iron with comparatively low phosphorus content, certainly not over 0.5 per cent.

Since only very moderate physical properties are required in this type of casting, methods have been successfully developed to make use of phosphoric iron with a final phosphorus content of 0.9 to 1.2 per cent. In order to achieve complete pressure tightness with this type of high-phosphorus composition, the most reliable method is to cast the bomb bodies vertically, with the tail uppermost and with the addition of a suitably designed feeding head on the top of the casting.

Centrifugal casting, where it can be applied, provides an admirable means of producing sound strong castings from high-phosphorus cast iron. A particularly interesting example is in the centrifugal casting of trench-mortar bombs.

The importance of casting temperature control is recognized by all foundrymen. The Shofield pyrometer is used in steelworks to measure the temperature of steel. It is easily modified for cast-iron foundry use and, for practical purposes, consists of a 4 ft. platinum-platinum rhodium thermocouple (diam. of wires 0.5 mm.), flex leads and a portable indicator. This gives temperature readings accurate to 2° or 3° C. (3 to 5° F.) in ten sec.

The Cambridge Instrument Co., Ltd., makes a workshop potentiometer for steel-melting temperatures that can be calibrated over the cast-iron range, and gives an accuracy of 1° C. (1.8° F.) in 2-3 sec. A sheath lasts up to 20 times with care, but the initial rate of breakage is higher until people get used to handling the pyrometer with reasonable care. The feature that appeals strongly is that temperature can be accurately and quickly determined through blacking or slag.

The results of accurate casting temperature control in ensuring soundness are most marked. Troubles due to mis-running, sinking and porosity can be minimized. Wasters, in certain castings that have to stand a porosity test, have been reduced from 20 to 5 per cent by casting temperature control. Porosity was at the ingates.

Summarizing what has already been published, it is recommended that between 0.5 and 1.0 per cent silicon should form the late addition, irrespective of the amount of silicon in the metal as charged to the furnace. Inoculation should take place as late as possible, since its beneficial effect disappears after an interval of 15-20 min. Machine tool castings, use of denseners, wartime mix for high-strength cast iron containing chromium, etc., are also discussed.

—*Foundry Trade J.* Vol. 70, Aug. 12, 1943, pp. 299-302; Aug. 19, pp. 325-328.

Castings for Marine Use

Condensed from a Paper,
Institute of British Foundrymen

In a ship, the stem, the sternframe, propeller shaft brackets and rudder frame come first to mind. These are the vital parts of a ship's structure, subject to considerable loads arising from vibration and bending forces when in service. In the case of large ships, these parts may be built up from individual castings of considerable weight, some well over 100 tons in the cast condition. For example, the cast-steel sternframe of the "Queen Mary" formed a composite casting of total weight nearly 200 tons.

In the present war, cast steel has been called to give great service in the construction of parts and fittings that have to withstand the shock of underwater explosion. In most cases cast steel and welded mild steel have provided the solution, the choice between the two being mainly a matter of economics.

In an inquiry into the failure of some

Suggestions for steel casting design

Information supplied by an Industrial Publication

Not only the quality of steel castings, but their practicability and production cost under ordinary foundry conditions are influenced by design. The following suggestions are offered as an aid to proper design.

1. Whenever possible, all sections should be designed for uniform thickness.

2. Structural design involving abrupt changes in section should be avoided.

3. Sharp corners at adjoining sections should be eliminated whenever possible.

4. When the structure becomes very complicated, it is better to break it into several components that can be cast separately and assembled by welding or bolting.

5. In designing unfed sections in "L" or "V" shapes, it is suggested that all sharp corners at the junction be replaced by radii so that this section becomes slightly smaller than that of the arms.

6. In designing sections that join to make an "X", it is suggested that two of the arms be offset considerably.

7. In the case of unfed "T" and "X" sections, the radii at the junctions should be relatively small.

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Diesel engine crankshaft webs made in cast steel, some years ago, it was found that fine star cracks developed in the periphery of the webs after they had been shrunk on the pins and body pieces; further, the cracks were found only after a lapse of time. The webs had been cast vertically, and the feeding heads had been removed by flame cutting. As the position of the cracks coincided with the position of the feeding heads, it was considered that during flame cutting, molten metal had filled the cracks and obliterated them, so that, in fact, the cracks had been there all the time, just below the surface.

It was also found that some manufacturers introduced chilling bars into their castings to hasten freezing, thus rendering the provision of ample feeding heads less imperative. These internal chilling bars in no way prevented the formation of defects, but simply transferred them to a point midway between the chilling bar and the surface of the casting. Further, any trace of rust on the bars would result in the evolution of gases. It was, therefore, decided to prohibit the use of chilling bars for steel castings intended for ships classed by Lloyd's Register of Shipping.

Subsequent experiment proved that best results were obtained when the webs were cast flat and slightly inclined, with three shrinkage heads, two of which were situated at positions that would afterwards be removed completely by boring out, thus removing any unsound metal.

—Sixth Edwards Williams lecture to the Institute of British Foundrymen. S. F. Dorey. *Foundry Trade J.*, Vol. 71, Sept. 2, 1943, pp. 3-6; Sept. 9, pp. 25-28, 33.

Manganese Steel Castings

Condensed from "Foundry Trade Journal"

Austenitic manganese steel has a manganese content of 11 to 14%, with 1 to 1.4% C. The silicon content is usually 0.3 to 1.0 max. 0.1 P, and max. 0.60% S. Sometimes known as Hadfield's manganese steel, it was first commercially developed about 50 years ago.

In the as-cast condition it is relatively brittle, but after water quenching from a temperature of approximately 1000° C. (1830° F.) it has remarkable toughness and wear-resisting properties, is practically non-magnetic and unmachinable. Its Brinell hardness is usually 180-200, and its resistance to wear is due to its capacity to harden under cold work.

For the production of light castings, two methods of manufacturing the steel are employed. The basic electric furnace, usually of the direct arc type, may be used, and the steel made by remelting steel scrap and ferro-manganese. The alternative method is to produce a dead mild steel by means of the cupola and converter, usually of the Tropenas side-blown type, and to add to this the requisite quantity of ferro-manganese, melted separately in a crucible or a small cupola.

This paper describes the production of metal for light castings made in a continuous casting plant, by the cupola-converter process, without the use of a holding furnace. Batches of steel must be delivered to a pouring station as and when needed.

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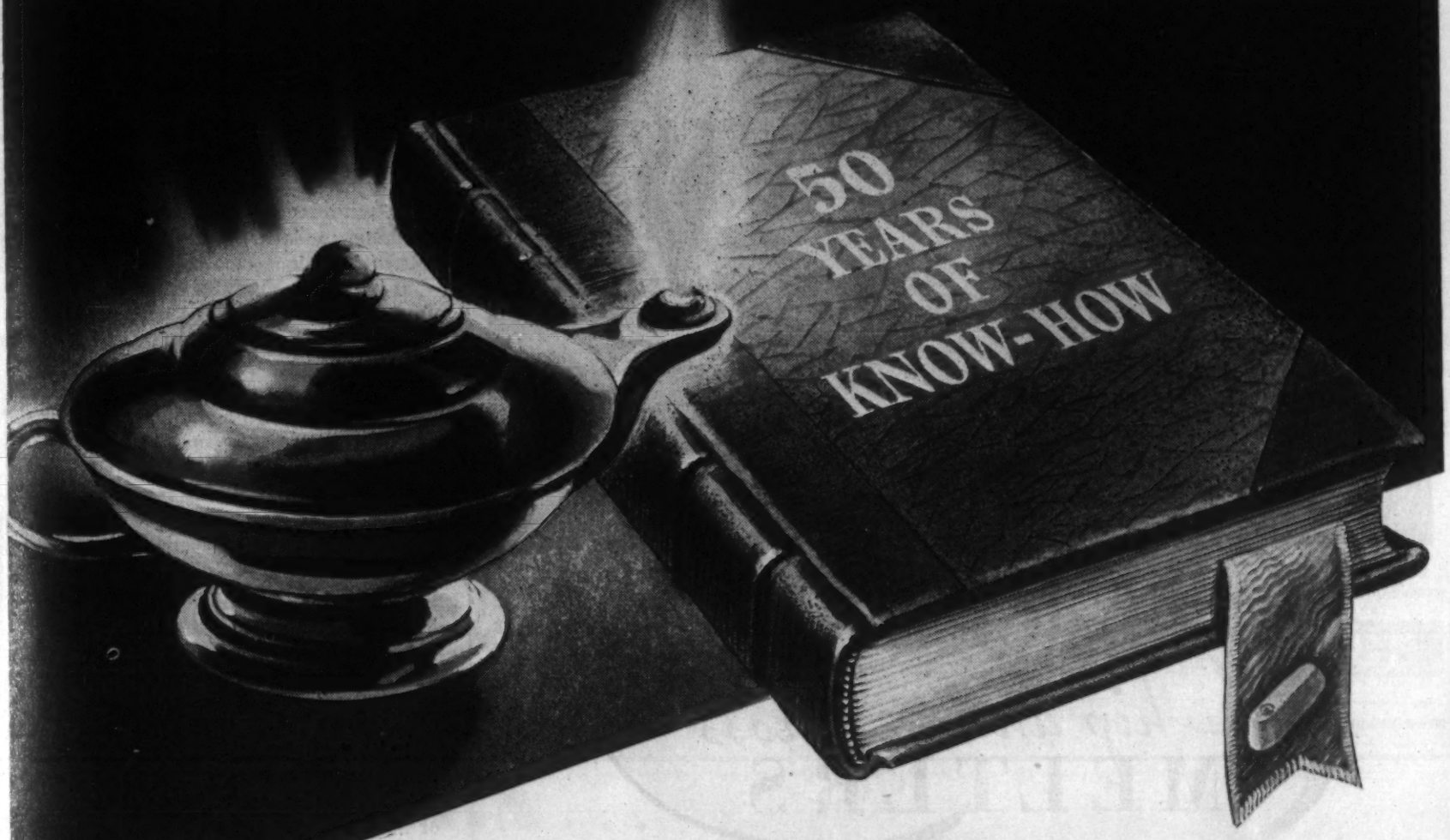

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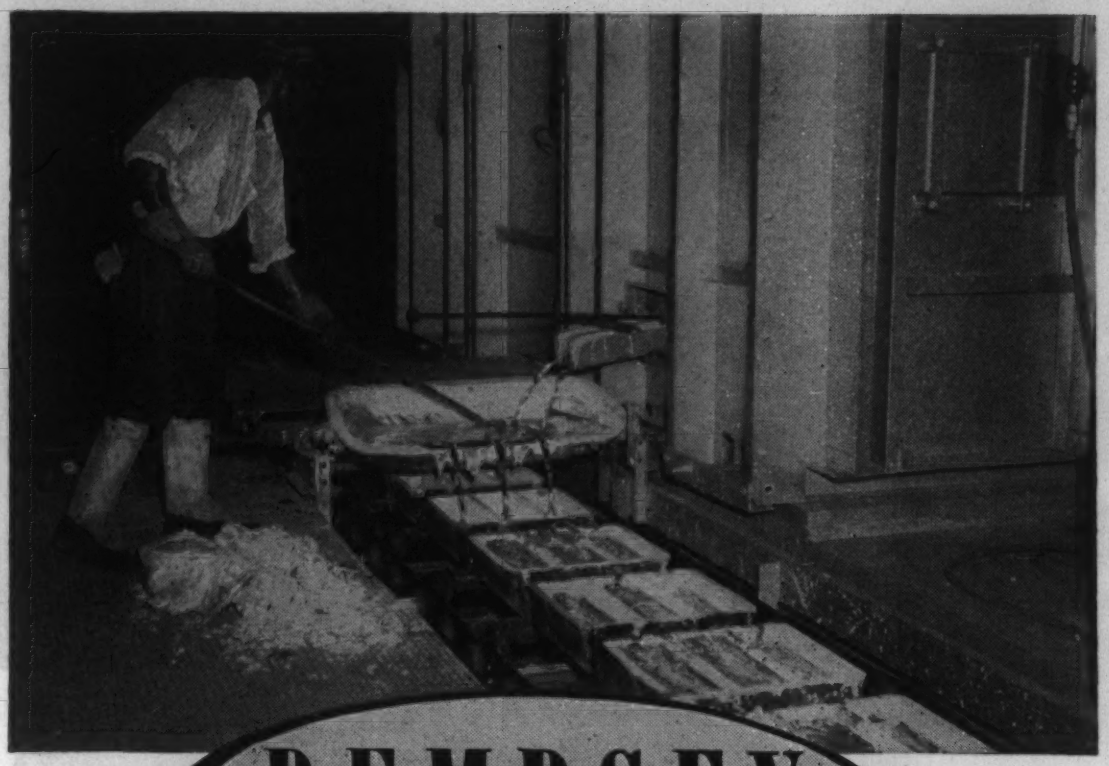
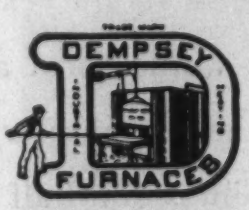


DEMPSEY *Chip and Dross* MELTERS



Precious aluminum, life blood of the airplane industry must be reclaimed in as pure a form as possible if the essential implements of war are to be produced on schedule. That is why so many DEMPSEY furnaces are being used for converting aluminum chips and dross into primary metal with a recovery rate of 85% to 95%.

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Method of Production

A weighed quantity of molten metal, sufficient for a heat, is taken from a cupola and transferred to a side-blown converter. While the metal is being converted, a weighed quantity of ferro-manganese is taken from a cupolette and transferred to the pouring ladle. The steel from the converter is teemed on to the ferro-manganese and the ladle is then taken to a pouring station.

In the as-cast manganese steel, part of the carbon present exists as free carbides, which are arranged in a network formation. This is the reason for the relative brittleness of the unheat-treated steel. The higher the carbon content, and especially if carbon is high in relation to manganese, the more carbides will be deposited out of solution during cooling from the molten state. The heat-treatment takes these carbides into solution, and they are retained in the austenite by quenching.

If a large quantity of carbides is present in the as-cast material, a long heat-treatment cycle at high temperature is necessary for solution. In a satsfactory manganese steel, carbon is not more than 1/10 of the manganese content. In making the steel by the converter process, a small amount of carbon, say 0.08%, is present in the converter metal, and this amount must not be exceeded.

When the converter metal is added to the ferro-manganese, in spite of the previous deoxidation with aluminum and the addition of ferro-silicon, there is a loss of manganese amounting to approximately 3% of that added. This loss is not accompanied by a corresponding loss in carbon, but if all conditions are correct the relation between carbon and manganese in the ferro-manganese is such that the analysis of steels produced by this process will show a ratio of between 10.5 and 11.1.

Should a large amount of converter slag, especially if highly oxidized, enter the ladle with the steel, a considerable manganese loss can occur without any appreciable loss of carbon, and this also throws the two elements out of balance.

—L. W. Bolton & J. Hill. *Foundry Trade J.*, Vol. 70, Aug. 19, 1943, pp. 319-323; Aug. 26, pp. 347-351, 353.

Annealing Malleable Cast Irons

Condensed from "Archiv Eisenhüttenwesen"

The influence on decarburization velocity of wall thickness, annealing time, temperature, gas composition, and of the content in the casting of manganese, nickel, chromium, vanadium, molybdenum, and sulphur was investigated on white-solidified cast iron in carbon monoxide-dioxide mixtures between 950 and 1050° C. (1740° and 1920° F.). The diffusion constant for carbon in iron was also determined.

The results are summarized as follows: (1) The decarburization velocity increases with increasing temperature and in the first two hrs. is several times higher than after about ten hrs. annealing, decreasing in time approximately hyperbolically.

(2) The gasification of carbon takes place practically only at the surface of the specimen. The carbon required for maintaining decarburization migrates from the interior to

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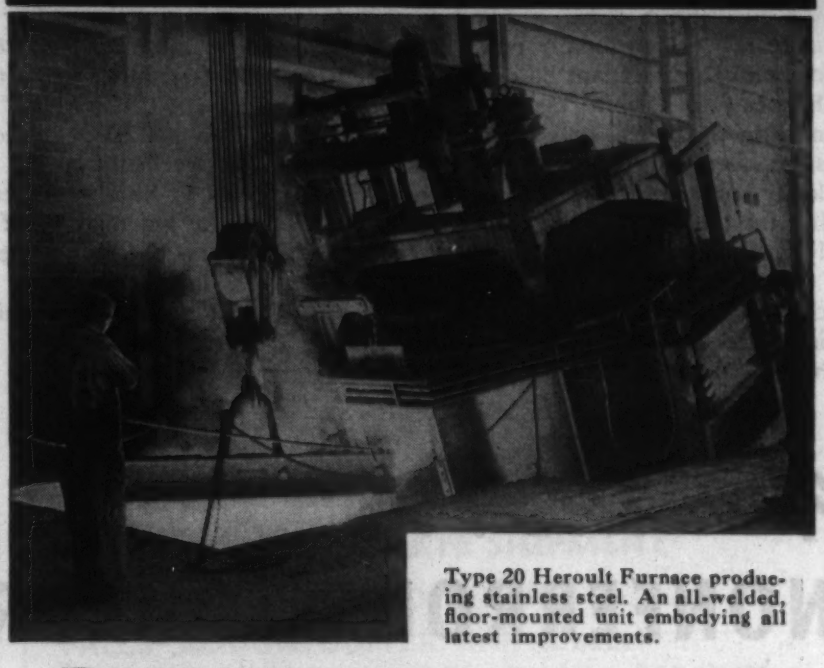

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the edges, and its diffusion velocity determines the decarburization velocity. This proves Ledebour's theory of the reaction.

(3) The fact established for steels that the quantity of carbon gasified in unit time increases proportionally with the original carbon content cannot be directly applied to hypoeutectoid white cast iron. For short annealing times, the primary cementite inclusions seem to decrease the diffusion velocity and thus the decarburization velocity, but for longer annealing times this is hardly noticeable.

(4) Low contents of manganese, nickel, chromium, and vanadium have hardly any influence on the decarburization velocity, higher contents having mostly an unfavorable one. The effect at 950° C. (1740° F.) is also unfavorable. Sulphur seems to decrease decarburization.

(5) The highest decarburization velocity is obtained, for low flow velocities, with a gas mixture about 28% CO_2 and 72% CO.

(6) Dioxide contents above 28% lead, at 1050° C. (1920° F.) to scaling of the iron and also to reduction in decarburization velocity.

(7) White cast iron can be decarburized in a gas mixture of a composition in the range of the wustite field, without scaling as long as a certain minimum of carbon is not exceeded. If this minimum is reached the dioxide content has to be reduced to avoid scaling.

(8) The results obtained with pure monoxide-dioxide mixtures can be applied also to the tempering in nitrogen-containing monoxide-dioxide mixtures with a favorable oxide ratio and a sufficiently high flow velocity. One has only to be careful that the decarburization reaction at the surface goes on sufficiently fast with respect of the carbon diffusion.

—W. Baukloh, F. Schulte & H. Friedericha. *Arch. Eisenhüttenw.*, Vol. 16, Mar. 1943, pp. 341-354.

For the . . .

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Photo taken in the foundry of The Hobart Mfg. Co., Troy, Ohio (Courtesy The Austin Co.)

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Malleable Iron Castings

Condensed from "Foundry Trade Journal"

There are three kinds of shrinkage, entirely different, and occurring at definite stages in the cooling of a metal from its highest to its lowest temperature: Volume contraction of the liquid metal, liquid shrinkage, and solid contraction.

To take care of "liquid shrinkage," it is essential to provide a reservoir of hot metal from which the casting can draw. Each individual casting has its own peculiar characteristics with regard to liquid shrinkage, and the necessary measures, must be devised to overcome possible defects from this cause.

The metal that the malleable founder pours into molds is a white cast iron, which for blackheart castings usually conforms to an analysis of 2.3 to 2.5 total C, 0.90 to 1.0 Si, 0.3 to 0.4 Mn, 0.07 to 0.09 S, and 0.15% maximum P. Such an iron must be cast at a high temperature, approximately 1450° C. (2640° F.); it has a high initial freezing range longer than steel and shorter than cast iron, and high solid contraction, all of which create problems for the foundryman.

The use of blind feeders has long been in vogue with the malleable founder, and such feeders have been utilized by the author's company for 15 or 20 years. However, three years ago, the author conducted a special investigation on the feeding of malleable-iron castings, and since then the results obtained have been used on a practical scale.

Like Taylor and Rominski, the author selected a spherical-shaped feeder, as it had the least surface area for a given volume, with consequent smaller dissipation of heat. The casting temperature of white cast iron is most important as, if on the low side, there is the danger of "misrun" castings, while if too high, greater liquid shrinkage ensues, due to heating up of the mold.

In arranging the gating of any casting the metal should enter the mold in a manner to cause least turbulence, and with speedy pouring to fill the mold as quickly as possible. The time taken for pouring different molds has been observed, and improved results have been obtained by altering the speed of running.

Generally speaking, the use of chills should be avoided, wherever it is possible to obtain soundness in a casting by feeding or by some other means, such as change of design. Molding sounds, synthetic sands, floor and bench castings, machine molding, etc. are also discussed.

—J. Roxburgh. *Foundry Trade J.*, Vol. 70, Aug. 26, 1943, pp. 341-345; Vol. 71, Sept. 2, 1943, pp. 9-14; Sept. 9, pp. 29-33.

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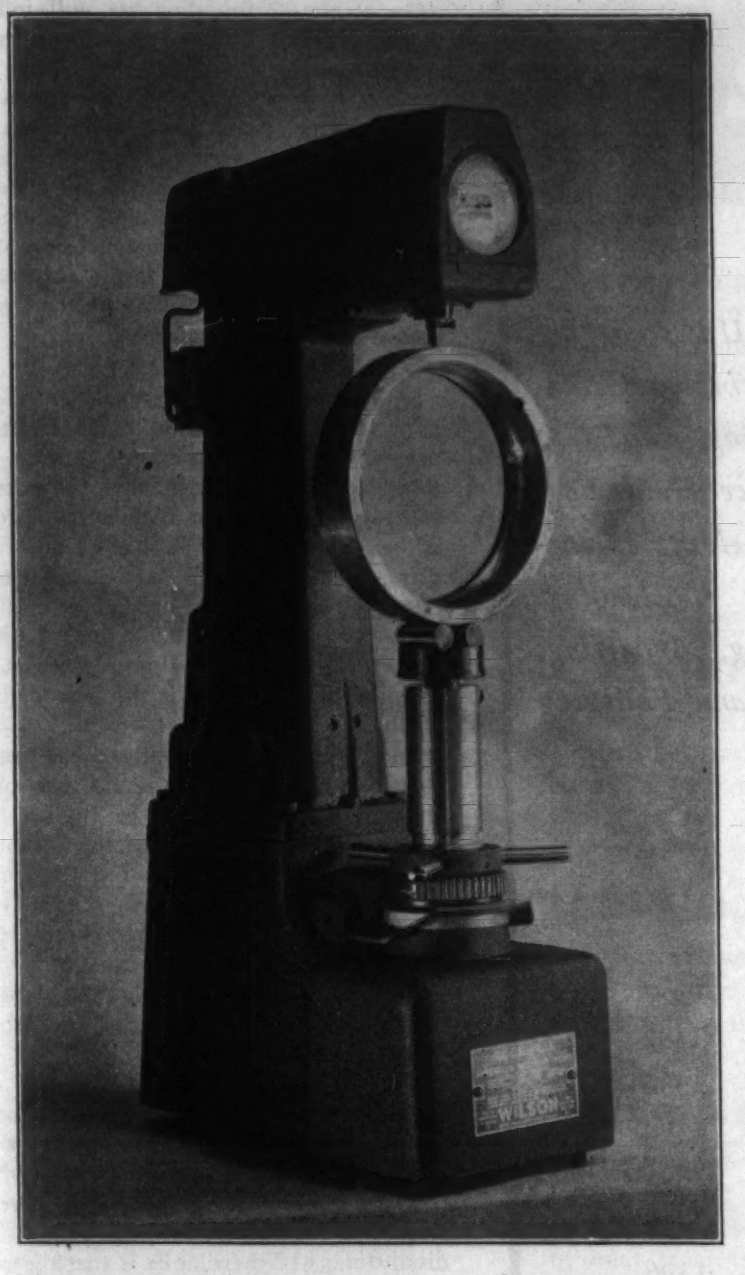

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Radiant Heat in Metal Finishing

Condensed from
"Sheet Metal Industries"

Although the utilization of radiant energy for heating purposes has long been known, it was not adopted for industrial metal finishing until recently, due mainly to conservatism and the high equipment cost. Likewise, since cellulose varnishes and lacquers dry almost entirely by solvent evaporation, a convection oven was quite satisfactory. The newer oil-modified synthetic resins, which must be polymerized by heat, require a long drying time in convection ovens. With radiant heat, these lacquers can be baked in 6 to 8 min., whereas 1 to 1½ hrs. would be required in a convection oven.

The physical laws controlling radiation are very different from those for conduction and convection. There are three main rules of radiant heating: (1) The temperature difference between the source and the work should be as high as possible, because the energy transmitted is proportional to the fourth power of the temperature difference. Also, the energy must be radiated at as high a rate as possible to limit the loss by convection. (2) Radiation is a far more rapid means of heat transfer than convection and conduction. (3) The air temperature in radiant heating ovens should be sufficient to ensure a minimum transfer of heat by means other than radiation. The temperature of the surrounding air will influence both the rate of heating and the temperature attained.

Radiant heat is best applied to articles having a relatively small heating capacity and requiring very rapid heating to a temperature not greatly in excess of their surroundings. It is not ideal for evaporation because the vapor formed must be removed from the vicinity of the liquid for evaporation to continue; this would tend to decrease the air temperature.

Efficient Radiator

An electric bulb is a very efficient radiator as it reduces convection and permits the use of a small temperature source. Although a carbon filament lamp is more efficient than a tungsten filament, the former is less practical due to blackening of the glass. The bulbs are very similar to ordinary light bulbs, but are run at 2500° K. to give a life up to 10,000 hrs. However, the filament is now in a more compact form so more of the energy is thrown on the reflector.

In the U. S. A. the wattage has been increased to 1000. The recent use of enclosed furnaces has led to higher heats, which must be counteracted by (a) bi-post lamps where the support for the bulb is heavy current carrying leads of iron-nickel alloy, which are sealed direct to the lamp, and (b) extension of the cap up the glass shank of the bulb, while the latter is gripped mechanically with an asbestos washer.

The latest innovation is the use of a sealed beam, combining a bulb, reflector and front dispersion lens. The reflector and front lens are made of hard glass, with the reflector covered with a layer of silver or aluminum deposited by vaporizing. The disadvantage of these units is that the whole unit must be replaced, not just the bulb. The cover glasses give a more uniform distribution of energy but absorb 20% of the incident energy.

The reflectors must not only have high reflectivity over their entire life, but must also be capable of being cleaned easily. They are generally pressings or spinnings.

Aluminum is probably most satisfactory. It must be over 99.8% pure. Copper and silicon impurities are most deleterious, while magnesium, manganese and zinc are not as harmful. In the range of 99.2 to 99.8% Al, the reflectivity increases linearly with the purity. With a regular polish, the reflectivity is 65 to 75% in the visible range; when chemically and electrolytically polished, the reflectivity increases to 80 to 85% and even higher in the infra-red field. All aluminum reflectors, therefore, are electrolytically polished.

The final step is to anodize the aluminum either by the Alzak (acid electrolyte) or the Brytal (alkaline brightening bath) process. The anodized aluminum is durable, has a very hard wearing surface, does not tarnish, is readily cleaned, and retains its reflectivity at high temperatures. When necessary, the anodic film is stripped, the reflector is repolished and reanodized. In the case of glass onto which aluminum has

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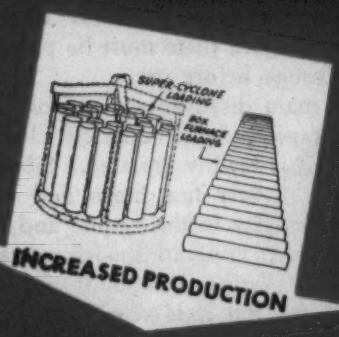
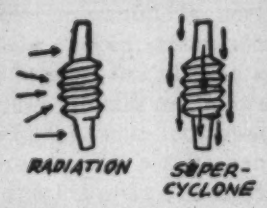
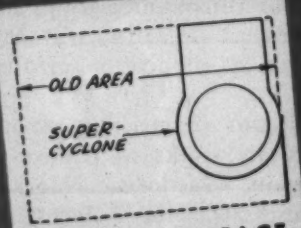


INCREASED PRODUCTION



STRAIGHTER WORK



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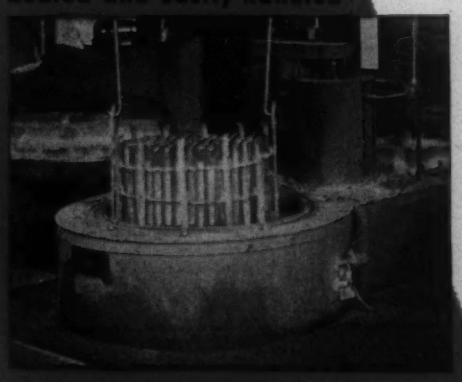

The revolutionary idea of heating steel to 1750°F. with recirculated air is embodied in the Lindberg Super-Cyclone Furnace. This principle with its accuracy, rapid uniformity and close control of heating offers many advantages, a few of which are listed below.

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STRAIGHTER WORK

The Super-Cyclone's 100% forced convection heating principle heats the work rapidly and uniformly and eliminates the possibility of one-sided or radiant heat from striking the charge and causing distortion. Straightening time is eliminated or reduced to a minimum. Valuable man hours are released from the press for other work.

LESS FLOOR SPACE

Based on averages of what the Super-Cyclone has done in other plants, you can figure that it will not occupy more than 1/3rd the floor area demanded by conventional equipment to handle the same or greatly increased production.

EXTRA MAN HOURS AVAILABLE

The Super-Cyclone method of handling work on fixtures or in baskets, eliminates the individual handling of parts in heating and quenching. In many plants, lone operators handle large loads through successive steps of heat treatment, for example, forgings are normalized, hardened and tempered in the same Super-Cyclone without being removed from the fixture.

SPECIAL HEATING

Because the Super-Cyclone can be heated at any desired rate to 1750°F. and cooled according to a definite schedule, it is well suited to stress relieving, cycle annealing, malleablizing, and other heating operations requiring a specific cycle. Write for the Super-Cyclone Bulletin 130.

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been volatilized in vacuo, the aluminum film must also be anodized before use.

Alternate Materials

Alternate materials for reflectors are brass, copper or steel sheet to which a reflecting surface has been applied. Gold plate has extremely good reflecting qualities in the infra-red field and is not readily tarnished. A nickel under-plate (at least 0.0005 in.) is used. The nickel must be highly polished before gold plating. The gold plate is generally 0.000010 to 0.000020 in. thick, although a greater thickness increases the life. The gold plate must be polished with a fine rouge before use.

The main disadvantage of gold is that it wears rapidly with repeated cleaning, although it is readily replated. Silver plating can give a very fine finish and has excellent reflectivity in the visible and infra-red, but tarnishes too rapidly for practical use. Rhodium plating (0.000005 in. min.) is very costly, but it is very hard, completely non-tarnishing and has a high reflectivity. Highly polished silver is the best underplate and must be used if the rhodium is to be plated onto iron, aluminum or solder; however, in other cases, nickel, nickel-silver, copper, brass or gold can be used.

When the rhodium plating wears, it cannot be stripped, but must be plated over with silver and then a new rhodium plate deposited. Chromium plating (with a nickel under-plate) is cheap and easy to produce, but it is little used because the reflectivity is not good for visible and infra-red radiation.

Except for chromium plating, any of the above alternates are satisfactory for reflecting surfaces as all give a performance of over 90%.

The reflectors are generally cleaned about once every six weeks to remove the condensed vapors. Methylene chloride is one of the most satisfactory solvents for polymerized and oxidized oils. Normal butyl acetate is also useful. The reflector is then wiped with a non-abrasive compound on a cloth or an emulsified preparation on a paraffin or water base. Especial care must be taken with the cleaning of gold because of its softness.

Not for All Paints

One of the reasons this heating method was not immediately popular was that many finishes were not suitable. For radiant heat drying to be most effective, the paint should be custom made. Most paints contain drying oils and heat polymerizing resins; radiant heating is most useful in finishing the latter. Solvent balance and dispersion demand more careful attention than with paints for convection ovens. Color is likewise more important than with convection ovens as light colors reflect the radiation. Finish (glossy or matte) is of no importance.

There is not much danger of burning, since the duration of the peak temperature is relatively short although the rate of heating is far more rapid than in convection ovens. In radiant heat baking, 350°F. is not often exceeded, but with dark paints where discoloration is not important, there is no reason why 450°F. should not be used. However, excessively rapid rates of heating darken light enamels, especially if organic pigments are used. With the energy limitations of present day furnaces,

Let's get on with the war

..AND SPEED THE AMMUNITION

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Reg. U. S. Pat. Off.

Let's keep hitting the Axis with everything we've got! If you have a metal cleaning operation, let us show you what a Pennsalt Cleaner can accomplish in getting it done in less time—or at less cost—or with more output.

Take this case for example: A well-known steel company was producing 0.30, 0.50 and 0.55 calibre cups for bullet jackets. Involved was a continuous washing, annealing, quenching, pickling and rinsing process. The components were carried through a perforated shell partly submerged in the cleaning solution.

When the Pennsalt serviceman called, he found that the cleaner then in use was only partly effective. Unsaponified oil was burning off in the annealing furnace, creating smoke and soot—and because the perforations in the shell became clogged, there were repeated delays due to cleaning difficulties.

When a fresh solution of Pennsalt Cleaner was used in the tank at one ounce per gallon concentration—*delays and cleaning difficulties stopped at once!*

Let our experienced technicians help you with *your* metal cleaning problems. Actually billions of cartridge cases, shell cases and bullet jackets—as well as great quantities of other ordnance and armament—have been most successfully cleaned with Pennsalt Cleaners.

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- Double flange top ring
- Extra pot thickness at liquid level
- Element — one continuous helix extra heavy rod
- Positive element support in recessed refractory wall
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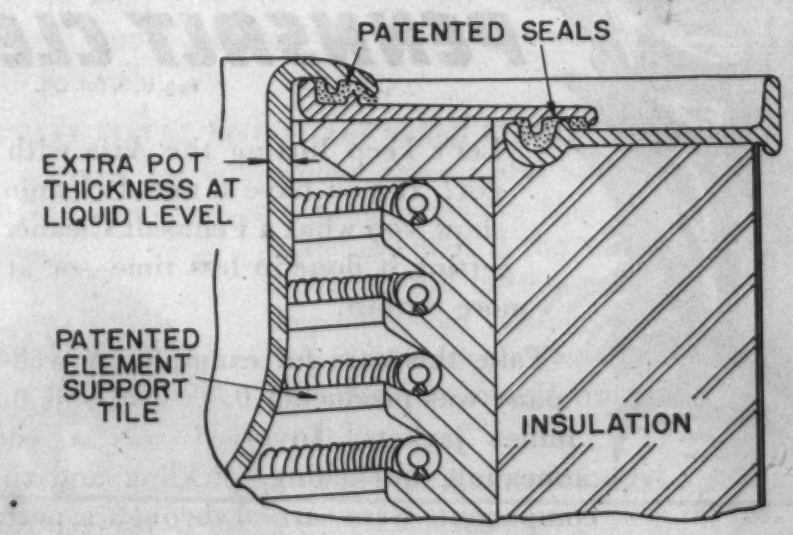

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Industrial Furnaces For All Purposes

the limiting time is generally due to furnace design rather than to the finish.

The fields of application can be divided into (1) low energy density and enclosed ovens; (2) any energy density and open units; and (3) high energy density and enclosed ovens.

The first type is used mainly for sheet metal articles of large area: mass ratio. The main limitations are temperature and quantity of heat. Probably 300° to 400°F. is an economical upper limit today, although there is no reason why 60°F. should not be a reasonable limit for enclosed types with reflecting interiors. In the U. S. A., the trend is towards enclosed types, so insulated that the air temperature is as high as possible and the heat transmission to the back of the lamp is low.

Although open units (the second type) are inefficient, there are cases where they are justifiable on the grounds of flexibility, *e.g.* touching up of painted articles and drying of water wet parts (where the amount of water to be evaporated is small). They are really only apparently inefficient since the time and labor to turn them into efficient applications would be uneconomical and since they dry at an unprecedented rate.

The third type is most promising. The drying of armatures and field coils after impregnation with varnish is not feasible with present low energy densities, but fair results have been obtained with ordinary electrical bar heater elements mounted in suitable units. In theory, there is no maximum temperature; practically, the temperature might be increased to 1100°F. with the use of anodized aluminum reflecting surfaces and hard glass sealed beam radiant heating lamps.

It is believed that the more recently developed gas radiators may open up a widening field for radiant heating. The equipment is cheaper and more sturdy, but an undue proportion of heat is lost in the products of combustion. The conversion of present day gas furnaces will not give optimum results as overheating must be guarded against and there is no provision against shading of the radiation from the walls.

The potentialities of gas fired radiant heating for paint baking ovens are very great and even surpass those of electrical types. In any case, the convection type of oven is obsolescent for the baking of paints and enamels on most sheet metal articles.

—J. H. Nelson & H. Silman. *Sheet Metal Inds.*, Vol. 17, June 1943, pp. 1039-1048; July, pp. 1213-1216, 1223-1225, 1228; Vol. 18, Aug. 1943, pp. 1393-1402, 1417; Sept. pp. 1579-1582.

Lead Plating

Condensed from "Metal Finishing"

The use of electrodeposited lead as a substitute for more critical metal coatings is expanding rapidly and from present indications will assume considerable importance during the war period.

Lead deposits can be used for the protection of iron and steel against corrosion and to obtain a corrosion resistant coating on non-ferrous metals. There are many special applications, such as resistance to chemicals or severely corrosive atmospheres,

Good rods depend on ALLOYS

The tremendous increase of production in our metal-working industries has been due to many factors, among which welding is important.

Welding rods of highly specialized character are required for varied and exacting uses; and to meet the need, alloys enter more and more into welding rod manufacture.

Alloys are incorporated either in the coating or in the rod itself — either for fluxing purposes or to make the weld stronger.

The Molybdenum Corporation has for years been a large supplier of alloys, metal powders, and chemicals for the welding rod manufacturer, among its products being these:

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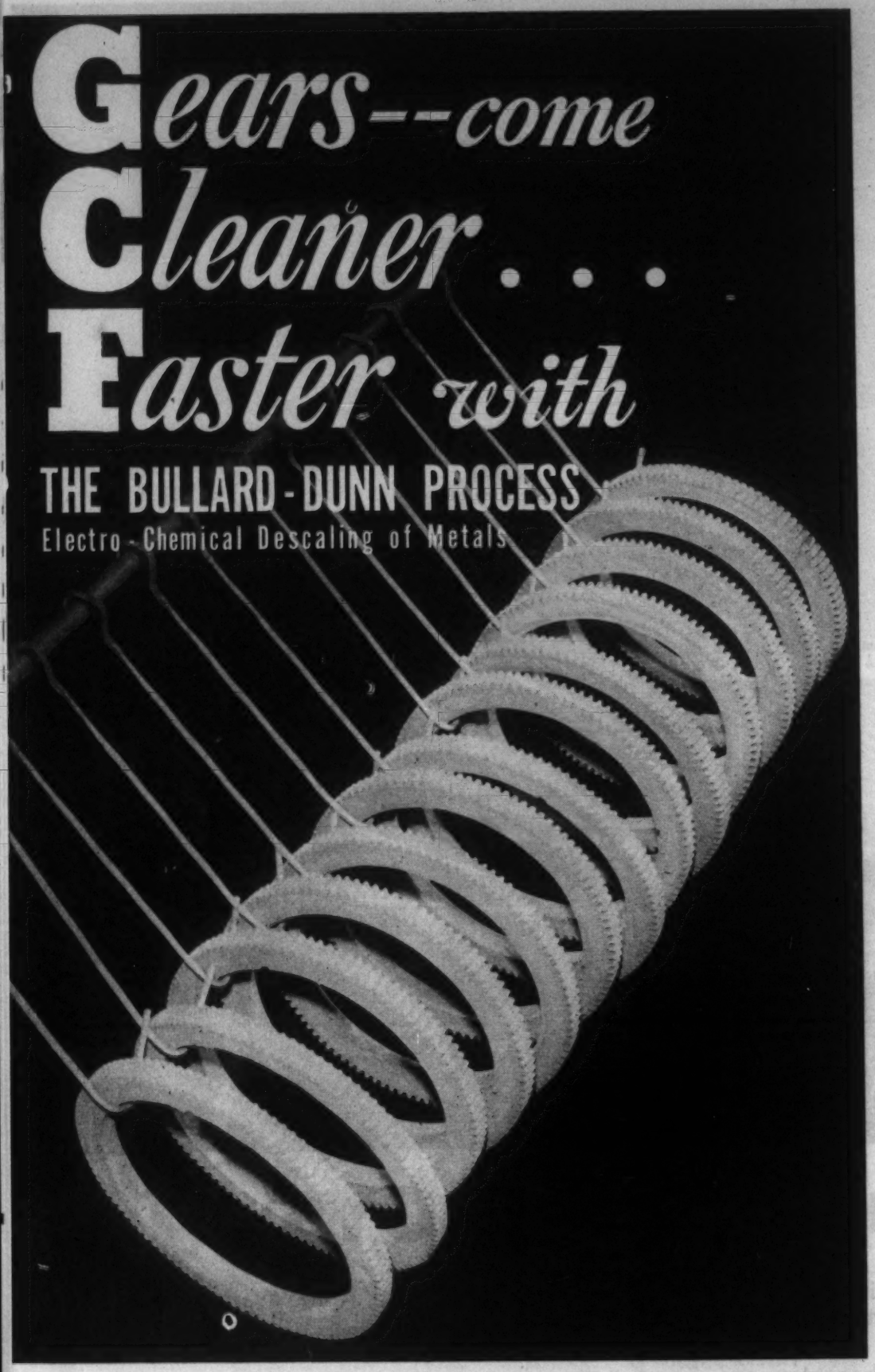

AND not only gears. With any metal parts you have to descale —your savings in time alone over old methods will justify its adoption. But there are other important advantages. For instance: No etching. No dimensional changes. Cleans out small recesses with ease. Requires no special skilled labor. Saves labor.

Save time on war production now—gain a big advantage for postwar competition later. Send samples and production data to

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where lead deposits are superior to cadmium and zinc provided sufficiently thick and pore-free coatings are used. In addition to these special applications, electrodeposited lead is now being substituted for cadmium and zinc where corrosion under ordinary conditions of exposure is encountered.

There is evidence that under some conditions of exposure, particularly in a marine atmosphere, lead is weakly anodic to steel and therefore will exert electrochemical protection. However, under many conditions lead is definitely cathodic to steel and therefore the plater should strive for the same qualities in lead deposits as in nickel or copper, where, for reasonable protection, the deposits must be heavy, mechanically sound, and free from inclusions or pores.

Based on the experience and data that are available, the author tentatively suggests the following coating thicknesses: For indoor exposures away from corrosive fumes, where 0.0001-0.0002 in. of cadmium or zinc has been found satisfactory, 0.0002-0.0003 in. of lead will be suitable. For outdoor exposure, lead thicknesses under 0.0005 in. should not be considered unless the articles are to be painted or lacquered. Incidentally, paint coatings adhere exceptionally well to electrodeposited lead. Prolonged protection of surfaces exposed to weather requires 0.001-0.003 in. Similar thicknesses are suggested for indoor exposure in a corrosive atmosphere. Severely corrosive conditions may require 0.003-0.004 in. Lightly burnishing or scratch brushing the lead surfaces after plating will improve the corrosion protection.

Lead plating solutions have a low throwing power, which must be taken into account in plating irregular objects. If an article is subject to abrasion, thicker deposits should be used, since thin deposits may be scratched through.

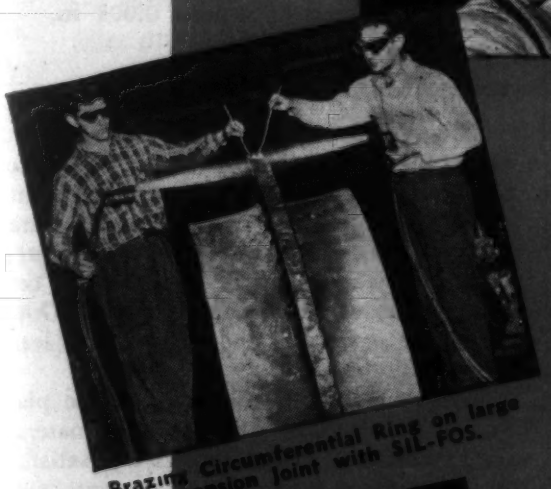
Salt Spray Test Results

Salt spray data are given for lead on steel and for lead over copper on steel. With 0.0002 in. of lead on steel in the 20 per cent salt spray at 90 deg. F. and at a 45 deg. angle rust shows in 31 hrs. With 0.002 in. of lead on steel, with the panel vertical, no rust appeared after 450 hrs. A 0.00002 in. layer of copper under the lead greatly increased the salt spray resistance.

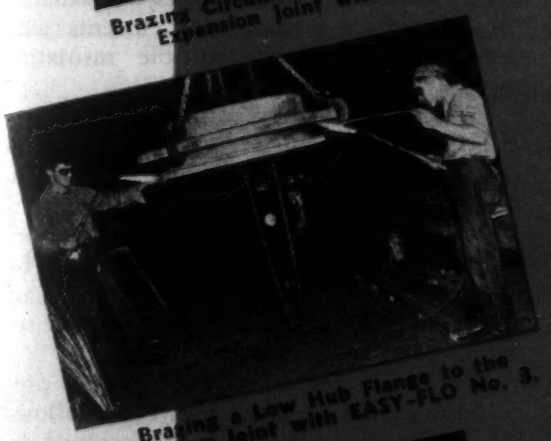
The lead fluoborate bath has proved to be the most practical for commercial electroplating, although the use of the recently introduced sulfamate bath is increasing. An alkaline lead plating bath with improved throwing power is soon to be introduced.

The fluoborate solution is essentially lead fluoborate, $Pb(BF_4)_2$, with an excess of free fluoboric and boric acids. Colloidal addition agents are required to minimize roughness, produce a finer crystal size and to prevent treeing. The lead fluoborate is prepared from basic lead carbonate, hydrofluoric and boric acids.

Lead metal concentrations of 16 to 32 oz. per gal. are suitable. "Free," or excess fluoboric acid is usually maintained at 2.5 to 4 oz. per gal. No uncombined hydrofluoric acid should be present. An



Brazing Circumferential Ring on large Expansion Joint with SIL-FOS.



Brazing a Low Hub Flange to the Expansion Joint with EASY-FLO No. 3.

Joining Back and Throat with EASY-FLO No. 3 to form the Intake Pipe.

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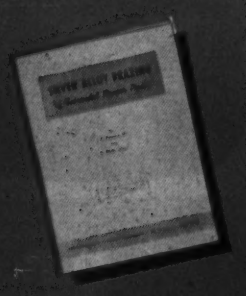
The fact that these low-temperature, free-flowing alloys make possible the fast, economical production of amazingly strong, reliable, leak-proof joints, is well established throughout the Marine field—established by universal use in the making of all kinds of Marine equipment and in the construction of ships' piping systems.

And evidence is mounting in Marine Copper Shops, where these alloys have replaced spelter brazing in fabricating large copper piping like the big intake illustrated, that their use is just as advantageous and just as economical on this larger work.

THIS BULLETIN WILL GIVE YOU THE STORY

It covers fully the silver alloy brazing procedure with which even inexperienced operators can fabricate the copper piping and piping combinations commonly used in the Marine field. Write for your copy today.



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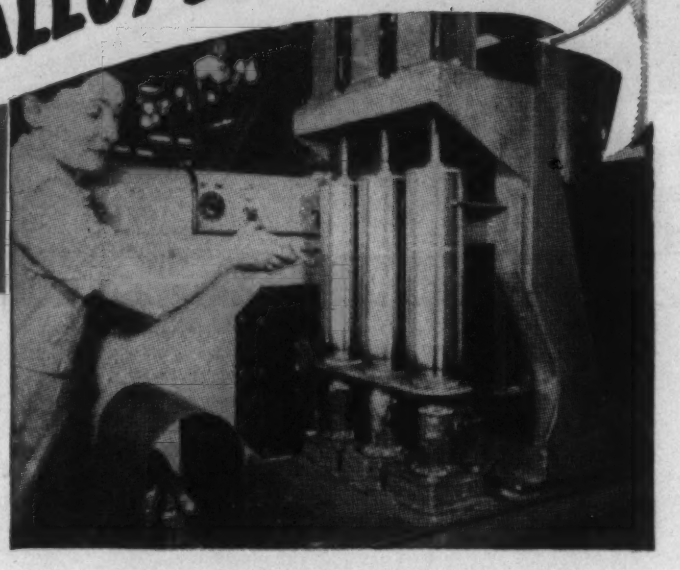

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excess of as much as 2 oz. per gal. of boric acid is beneficial and retards precipitation of lead fluoride. A glue concentration of 0.02 to 0.04 oz. per gal. gives the smoothest deposits. The glue to be used should be tested for its suitability on a small scale before adding it to a large bath. Before the glue is added the solution should be filtered, since sulfates present in the make-up chemicals or water cause precipitation of lead sulfate. Directions for analysis of the solution are given.

If an electrometric pH apparatus is available the proper acidity can be maintained by adding fluoboric acid to give a pH of 1.0 to 1.5. The glue concentration is controlled by observing the work, or by making a small scale test, *e.g.*, with a Hull cell. An excess of glue can be observed at 500 diameters magnification as dark-colored inclusions. The cathode current density is usually in the range of 5 to 30 amp. per sq. ft., though for smoothest deposits not over 15 amp. per sq. ft. is used. For thin deposits with agitated solutions, 80 amp. per sq. ft. may be used. At 15 amp. per sq. ft., 28 minutes are required to deposit 0.001 in.

Voltage Required

The voltage required is usually 1 to 2 volts for tank plating, or 6 volts for barrel plating. The temperature is not critical, 75 to 100 deg. F. being satisfactory. Anodes should be the purest chemical lead. As little as 0.08 per cent copper adversely affects the deposit. Other impurities cause the anodes to scum, leading to rough deposits.

Tanks lined with rubber, synthetic plastic, tempered glass, or a ceramic material are satisfactory. Lead linings are satisfactory if protected from stray currents with glass sheets or other suitable insulating material.

Pretreatments are similar to those required in nickel plating. Anodic electrocleaning, rinsing, acid-dipping in hydrochloric or sulfuric acid, followed by thorough rinsing, is usually a satisfactory treatment. Castings should be cleaned by sand or shot blasting. A copper strike of about 0.00002 in. is often beneficial in securing good coverage and adhesion.

Lead is a cumulative poison, and precautions should be taken to avoid swallowing lead salts. The hazards involved in preparing the fluoborate solution may be avoided by purchasing an already prepared concentrated solution. There are several such concentrates on the market. Lead plating must not be used on any article directly or indirectly in contact with foodstuffs.

—Myron B. Diggin, *Metal Finishing*, Vol. 41, July 1943, pp. 418-422.

Rifle Drilling with Carbides

Condensed from "American Machinist"

Carbide tipped standard drills from 0.293-0.781 in. diam. are being made, as well as a 1.150 in. diam. drill of different design for drilling an air cylinder hole in the receiver body of a 20-mm. automatic cannon.

What's your welding "KNOW-HOW" on these two metals?

Wrought Iron

1. Q. What filler metal should be used?

A. In welding wrought iron best results are gained by using a standard mild steel filler metal or a rod containing small percentages of alloying elements. These rods are preferred over wrought iron filler metal where welds of high corrosion resistance are required.

2. Q. When the metal first appears molten, is it ready to weld?

A. Fusion of the slag content in wrought iron at about 2100°F gives the metal a deceptive molten appearance. However this is far below the proper welding heat of 2700°–2770°F. Therefore the flame or arc should be applied until a puddle of molten metal appears. This molten puddle should be maintained while filler metal is applied.

Galvanized Steel

1. Q. How may galvanized steel be welded to have a minimum burning away of the galvanized coating?

A. To obtain this result galvanized steel should be oxyacetylene braze-welded with Airco No. 22 manganese-bronze rod, and Airco Hi-Test Brazing Flux. Fusion welding by flame or arc with steel welding rods or electrodes is likely to destroy the galvanizing near the weld and expose the base metal to corrosive attack.

2. Q. How should flux be used?

A. Airco Hi-Test Brazing Flux should be applied to both sides of galvanized parts, and to inside and outside of pipe and fittings. The flux application stops zinc fuming and thus preserves the galvanized coating under the welding heat.

HERE'S YOUR "KNOW HOW" GUIDE FOR WELDING MANY METALS

Procedures for welding most commercial metals are given in the Airco manual, "Welding Procedures". Welding novices and even experts will find much valuable information both on methods and materials recommended for best results. Send for your free copy by filling out and mailing the attached coupon..

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WORLD'S FINEST METALLIZING EQUIPMENT

In the case of the smaller drills, the drill may be made from drill rod, but better results are obtained with SAE 3115 Aerocase hardened to a depth of 0.003-0.005 in. before brazing in the wear plates and tip. Case hardening minimizes the danger of picking up chips and slight tears on the soft core of the barrel when drilling. Seats for the carbide tip and wear plates are milled in the drills. HD Firthite is used for the cutting tip, while T-16 Firthite is used for the wear plates. Handy and Harmon's Easy Flow No. 3 is used for brazing the sintered carbide.

The drill tip is butt-welded to the conventional fluted type seamless tube shank before the drill is sharpened. The 0.293 in. drill, which is used for drilling 30-cal. rifle barrels, an average feed of 2 in. per min. is used at 2,800 r.p.m. Each drill is good for 70 to 75 barrels before resharpening.

The larger drill has a single lip tipped with carbide and backed up with two carbide wear plates. Chip breakers, ground as steps on the cutting edge, split the chips while drilling and reduce the possibility of plugging. The drill tip is screwed into a 68-in. long drill extension of SAE 1020 seamless tube. At 600 r.p.m., a drill feed of 7/8 to 1 in. per min, can be used with a life of 10 hrs. or more before resharpening.

As compared with high-speed steel drills, feeds have in some cases been doubled. The carbide wear plates are used to maintain the accuracy of the drill and to produce smooth holes with minimum run-out.

—T. R. Skofteland, *American Machinist*, Vol. 87, Aug. 19, 1943, pp. 83-85.

Stored Energy Welding of Mild Steel

Condensed from an American Welding Society Paper

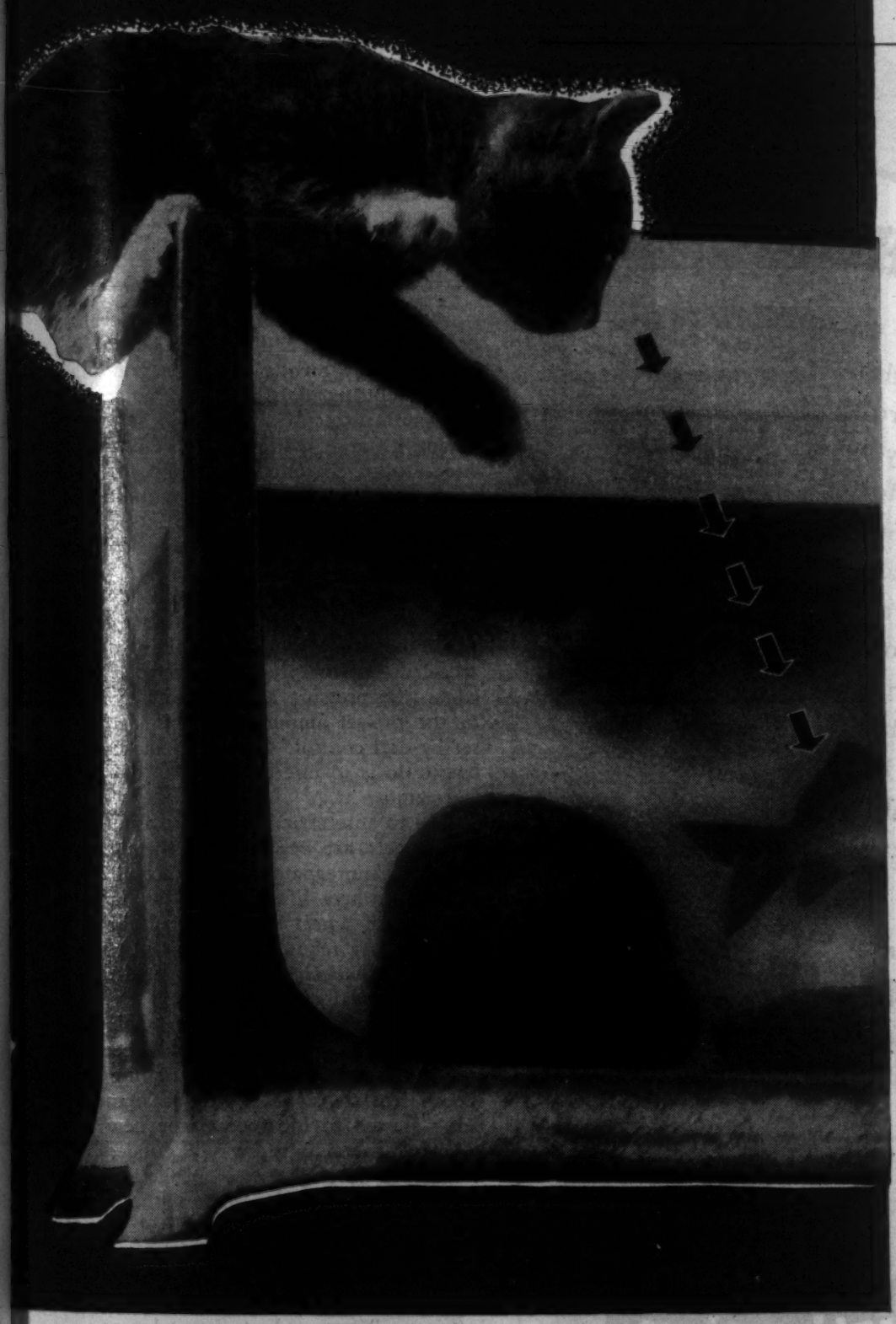
A stored energy welder was purchased by the Yellow Truck and Coach Mfg. Co. to study its welding characteristics on copper, stainless steel, and mild steel as well as aluminum. The studies on mild steel were especially interesting because of uniformity and minimum indentation found when using the stored energy machine.

Since the weld time was virtually constant and the heat and pressure controls were flexible, considerable study was made of the welding characteristics of the mild steel. Runs varying both heat and pressure were made from the start of coupon adherence to the point at which the electrodes fused to the metal, in order to get as complete data as possible.

Results of this study showed that the welding range of mild steel falls into four definite zones, which are controlled by weld bead growth. Welding in the third zone proved to be the most reliable and best for production work from the standpoint of metal finishing, tip life, and omission of flashing, spitting and extruding while welding.

Quality of the welds made on a stored energy machine is very uniform; and while slower than a.c. equipment, this machine is considered competitive because of the greater uniformity and fast weld time

Curiosity killed the cat



Yes, it may kill cats! But a lively sense of curiosity may also kill many an old-fashioned way of doing things.

The driving urge to *know*—to *find out*—is constantly discarding old, and discovering startlingly new manufacturing processes . . . techniques . . . applications. We have in mind, of course, welding and how the *curiosity* of production men finds ever-increasing uses for it and better electrodes with which to do the job.

Scientific *curiosity* has always been a vital factor in the intensive and continued development of **McKay Stainless, Alloy,** or **Mild Steel Welding Electrodes** . . . their perfection the result of constant research in one of the nation's foremost technical institutes.

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Curiosity as to how McKay products may improve *your* manufacturing processes will find us eager to cooperate.

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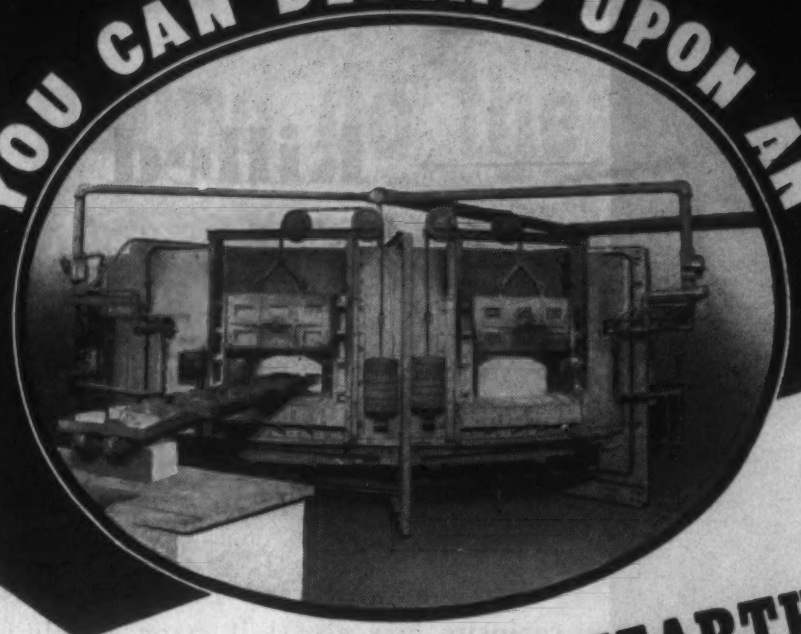

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which localizes heat. This advantage is applicable to the lighter metal gages only of 1/16 in. thickness or less. Heavier gages can be welded, but require much higher heat settings and have the usual heavy indentation of the spot weld. The upper limit of the machine used was 10 gage mild steel.

Enough information was obtained from the data to demonstrate the necessity for a weldability specification on mild steel, if close control of weld strength uniformity is necessary. The variation in steel weld strength found was much greater than that of the machine; in at least one case, good welds were impossible to make with otherwise good steel.

Steel weld strength variation will have to be studied in the future if real weld consistency is to be obtained.

—J. M. Diebold, *Am. Welding Soc. Paper*, October 1943 meeting.

Brazing Carbide Tools

Condensed from "Tool Engineer"

A new tool grinding principle, developed by Carboloy Co. and Edison General Electric Co., may revolutionize the grinding of carbide cutting tools by making unnecessary the employment of skilled labor, as well as saving grinding wheels. Top faces of carbide tools are ground in from 8 to 30 sec. per tool, and a good average grinding time covering all faces is 25 sec.

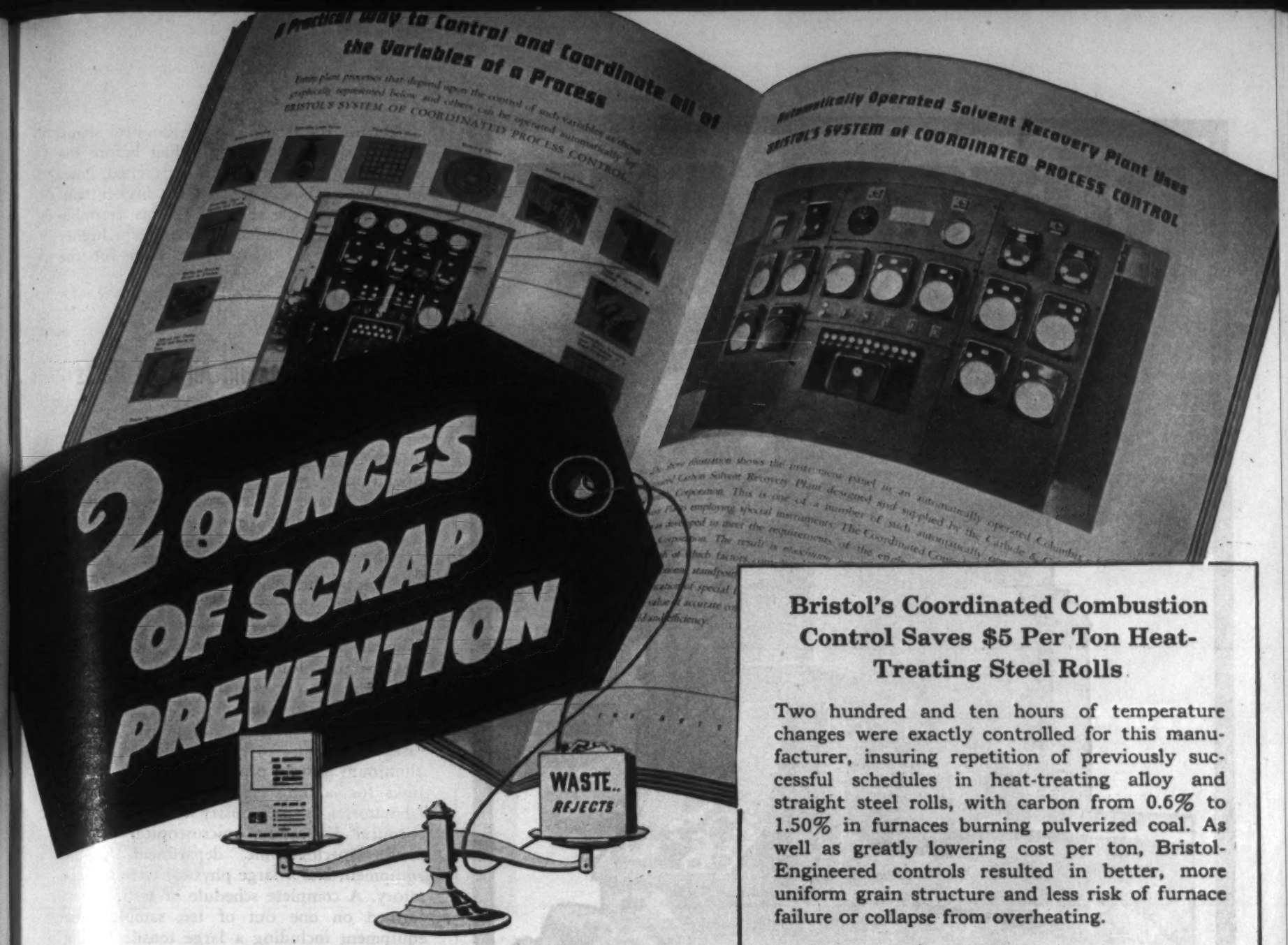
Holding the tool against the wheel under constant and controlled pressure insures maximum grinding speed consistent with the quality of finish, wheel life and heat generated. The tool is brought against the wheel under low pressure to remove jagged edges, the pressure automatically increasing to the pre-set amount. The time cycle is set by dial control, so that all the operator has to do is to insert the tool in the holder and remove it.

Due to automatic control the usual resinoid wheels are replaced by metal-bonded diamond impregnated wheels, resulting in increased wheel life. Difficulties in using this type of wheel have centered about the fact that they require a higher tool pressure against the wheel, which mitigated against correct manual application.

While developed for carbide tool grinding, the principles have already been applied in a limited way to grinding high-speed steel tools. Design development is being started to incorporate the new principle in general purpose tool grinders.

Another development is an electronic induction equipment for the routine brazing of carbide tools, using any suitable brazing medium, including copper. Advantages claimed are: Convenience, speed, simplicity, accurate and automatic control, low operating cost, cleaner and consistent brazes.

In this method, the operator merely attaches the correct coil for the tools to be brazed, sets the control dials to predetermined values, and pushes a button. In addition to an oscillator, the only equipment required to braze tools by the electron tube induction method is a table carrying tool holding fixtures and the necessary water-cooled coils to be connected to the oscillator.



Saving scarce raw materials by eliminating waste and rejects . . . is only one of the many wartime problems being solved today with the help of Bristol's instrument engineering. In many cases, sending for one of Bristol's instrument-data bulletins has been the first step towards substantial savings.

CHECK *YOUR* PROBLEM HERE:

1. Lack of skilled men?
2. Shortage of raw materials?
3. Need to increase output without increasing space or equipment?
4. Unnecessary spoilage and rejects?
5. Errors in putting new products into production?

Write for Bulletin 512 — Facts, Case Studies, Results of Complete Automatic Control of Plant Processes

Here, in one concise bulletin, are the essentials of Bristol's System of Coordinated Process Control, including list of applications and outline of what has already been achieved by many manufacturers in food, textile, metal, plastics, rubber and other process industries. Write for it today, together with any of the other free bulletins described at right, addressing The Bristol Company, 114 Bristol Road, Waterbury, Conn.

BRISTOL ...Gives YOU the Most from Heat

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

ARMY E NAVY

THE BRISTOL COMPANY, Waterbury, Connecticut

The Bristol Co. of Canada, Ltd.
Toronto, Ontario

Bristol's Instrument Co., Ltd.
London, N. W. 10, England

Bristol's Coordinated Combustion Control Saves $5 Per Ton Heat-Treating Steel Rolls

Two hundred and ten hours of temperature changes were exactly controlled for this manufacturer, insuring repetition of previously successful schedules in heat-treating alloy and straight steel rolls, with carbon from 0.6% to 1.50% in furnaces burning pulverized coal. As well as greatly lowering cost per ton, Bristol-Engineered controls resulted in better, more uniform grain structure and less risk of furnace failure or collapse from overheating.

★

FREE—These Clear, Concise, Complete Bulletins Sum Up Latest Advances in Instruments for Your Industry

THE BRISTOL COMPANY
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☐ Please send me free Bulletin 512, together with other bulletins checked here.

☐ Bulletin T302 — Describes Bristol's Full-Compensated, Liquid-Filled Recording Thermometers, desirable for a wide variety of critical temperature-measuring problems; nomenclature, parts, schematic diagrams, and partial list of available charts.

☐ Bulletin 536 — Modern pH instruments for exact measurement and automatic control of hydrogen-ion concentration are here described, together with new glass electrode method.

☐ Bulletin A112 — Bristol's Free Vane Controllers for temperature, flow, liquid level, pressure, draft, humidity, pH value and time program — analyzed and described with special attention to new convertible feature permitting adaptation to changing processes.

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ROTOBLAST

SIMPLIFIES BLAST CLEANING

★ Airless **ROTOBLASTING** — simplifying work in so many war plant cleaning departments today—multiplies blast cleaning speed many times over. The *reason why* lies in higher abrasive speed and impact, less delays and greater production possibilities when the **ROTOBLAST** unit is incorporated into Barrels, Tables and Cabinets adapted to fit your requirements.

The Pangborn **ROTOBLAST** is designed to do a **BIG JOB** with *little* effort. This means a cleaning department reduced to one operator for two machines, with an unskilled laborer for help in loading and unloading. Gone is the high labor overhead with its uncertain human factor Cleaning speed becomes regular, certain, predictable. Costs are down. Production is up.

ROTOBLASTED work is free from sand and scale. **ROTOBLASTED** work is easier to grind and machine. Therefore tools last longer. **ROTOBLASTED** work has fine uniform appearance.

For ECONOMY—SPEED—SATISFACTION—use **ROTOBLAST.**

BARRELS • TABLES • CABINETS

PANGBORN

WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT

PANGBORN CORPORATION • HAGERSTOWN, MD.

During the heating cycle, the steel shank heats faster than the tip. Just before the correct brazing temperature is reached, however, the carbide tip reaches a higher temperature than the shank. This is desirable since brazing effectiveness requires a higher temperature for the carbide than for the steel.

—*Tool Engineer*, Vol. 12, June 1943, pp. 91-92.

Forging Aluminum Aircraft Parts

Condensed from
"Automotive and Aviation Industries"

The experience gained from steel forging operations during peace has enabled Chevrolet to overcome problems posed by aluminum forging. Starting from scratch, the company has commissioned a new building in which is installed the latest types of forging equipment. Aluminum, requiring about three times the hammer capacity of comparable steel forgings, works havoc with even the finest die steels, and requires special metallurgical treatment.

Among the present products of this Chevrolet plant are propeller blades for controllable-pitch airplane propellers, crankcase sections and covers for engines, forged aluminum pistons, propeller hub pistons and links for landing gear. One of the finest laboratories in the industry includes a "wet" chemical laboratory, microscopical department, spectographic department, X-ray equipment and a large physical testing laboratory. A complete schedule of tests is performed on one out of ten samples, the equipment including a large tensile testing machine.

Raw material for the propeller blade comes in the form of long rolled aluminum bars, which are cut to length on abrasive cut-off saws and centered with a portable hand tool. Lathes remove a heavy cut on the o.d. and turn down one end to serve as a tong hold. The blade end is flattened in a No. 5 roll, thus preparing the billet for the 35,000-lb. hammers. After forging, flash is removed on a press and band saw, which also cuts off the tong hold, now used as the test piece. The hub end is heated to 850° F., after which two bearing races are slipped on. The hub end is upset and gathered in a 7½-in. forging machine, leaving the bearing races loosely mounted between the hub end and the blade.

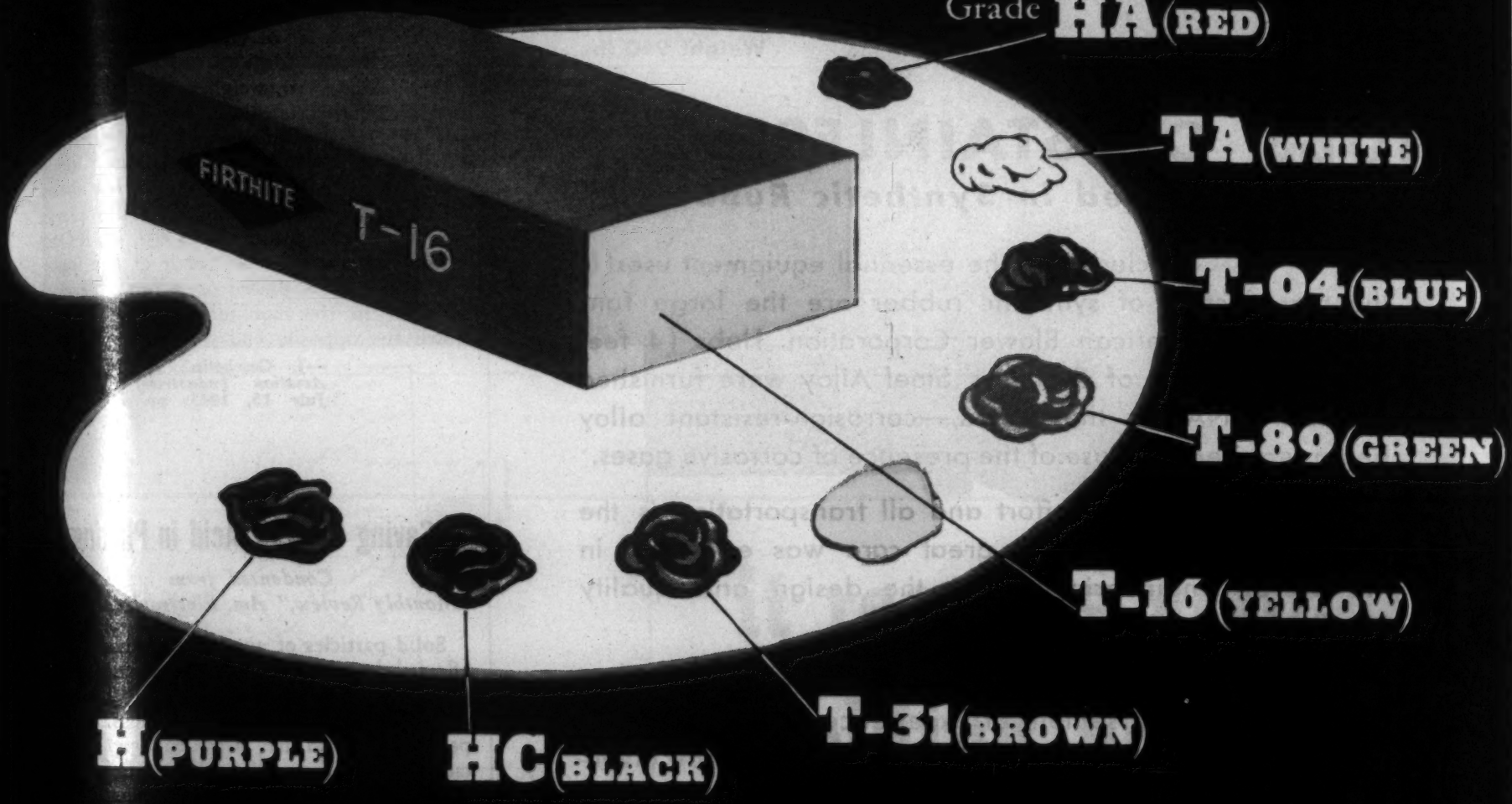
Now the blade is given the solution treatment in an electric furnace unit, holding it at 960° F., 6 hrs. full heat, 12 hrs. cycle, followed by quenching in hot water. Aging is handled in a mechanized furnace, 175 ft. long, holding the work for 16 hrs., 8½ hrs. being at full aging temperature.

Handling Crankcase Forgings

The crankcase forging is produced by a unique process, the raw material being received in the form of cast aluminum billets, 12 in. square, which are reduced to 9½ in. round cornered squares in a forging press. Resulting billets are cut into short blanks on an 84 in. band saw, the ends then being polished and ground by hand to remove tool marks.

These are now forged into circular biscuits on the same press in a single stroke. They are re-heated to 850° F. in preparation for

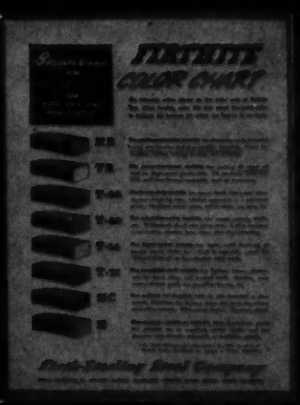
Firthite "Color-Branding" GETS A BIG HAND FROM COAST TO COAST



COLORS, on Firthite Sintered-Carbide Tips, are proving a most popular means of telling one grade from another. The color scheme recently introduced by Firth-Sterling, as another service to Firthite users, sets a convenient standard for the industry. A Firthite Engineer will gladly explain how this color system can be used to advantage in your shop.

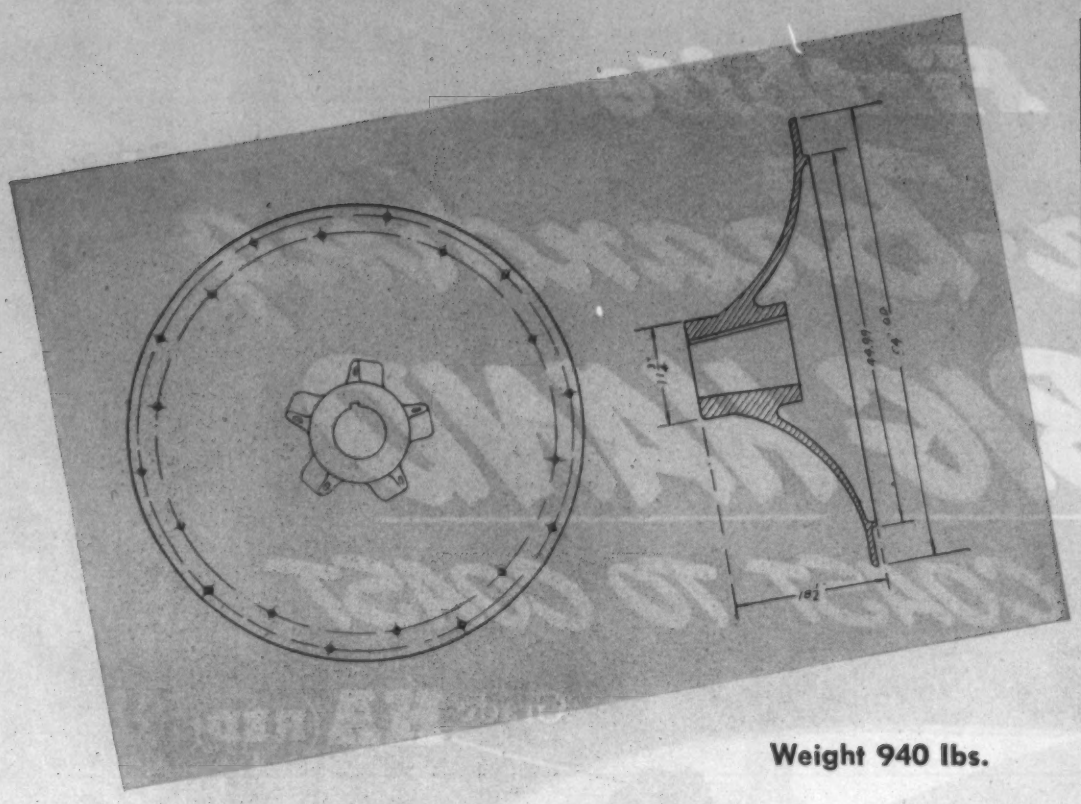
Send for **COLOR CHART**

Handy guide to selection of Firthite



Firth-Sterling Steel Company

OFFICES: McKEESPORT, PA.-NEW YORK-HARTFORD-PHILADELPHIA-CLEVELAND-DAYTON-DETROIT-CHICAGO-LOS ANGELES



Weight 940 lbs.

HUBS OF STAINLESS STEEL

For the Fans Used in Synthetic Rubber Plants

● Included in the essential equipment used in the manufacture of synthetic rubber are the large fans built by the American Blower Corporation. Hubs (4 feet in diameter) cast of Stainless Steel Alloy were furnished by MICHIANA for these fans,—corrosion-resistant alloy being required because of the presence of corrosive gases.

So vital to the War effort and all transportation is the production of rubber that great care was exercised in the overall engineering and in the design and quality of all the installed equipment.

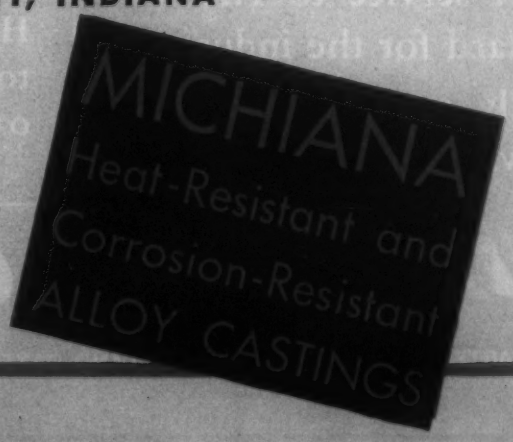
MICHIANA Heat- and Corrosion-Resistant Alloy Castings have had the endorsement of experienced production men for many years. MICHIANA experience covers a wide diversity of alloy casting production and application during over a quarter of a century of specialization in this field.

Recommendations that you will find helpful are yours for the asking.

MICHIANA PRODUCTS CORPORATION

MICHIGAN CITY, INDIANA

- Muffles
- Boxes
- Rails
- Rolls
- Sprockets
- Retorts
- Pots
- Grids
- Tubes
- Chains



this operation. The biscuits are blocked or rough forged in a 20,000-lb. hammer and finish-forged on the same type of hammer.

On some of the larger crankcases the forging is done on the 35,000-lb. hammer. The work is trimmed in a press and re-heated for each of the forging operations. Finished forgings are given the solution heat treatment and aging treatment.

All forgings, except propellers, are dipped in caustic soda solution, rinsed in clean water, dipped in nitric acid, then final-rinsed to bring out surface defects, to be removed in the cleaning room, where they are ground, burred and polished before inspection and shipping.

The 3000-ton hydraulic press exerts its pressure by a water and soluble oil mixture, which is pumped under a pressure of 4500 psi against the top of the ram cylinder. Pressure is created by two 100 g.p.m. pumps driven by 300 h.p. motors. An accumulator system to store pressure consists of four air bottles and one "air-over-water" bottle, all having a capacity of 900 gal. each.

For crankcase forgings cast ingots, 12 in. by 12 in. by 9 ft., weighing 1500 lbs., are used, having a tensile strength of 39,000 psi. When cogged down the billets' strength is increased to 55,000 psi. The cast ingot is heated in a furnace to 720° F. for about 3¼ hrs. It is then moved to the press, where it is cogged down to a 9½ in. R.C.S. billet, using a Vee die. Half of the ingot is cogged down, placed on a turntable and reversed in the manipulator jaws to cog down the opposite end.

—J. Geschelin. *Automotive & Aviation Industries*, Vol. 89, July 15, 1943, pp. 20-23, 94.

Saving Chromic Acid in Plating

Condensed from "Monthly Review," Am. Electroplaters' Soc.

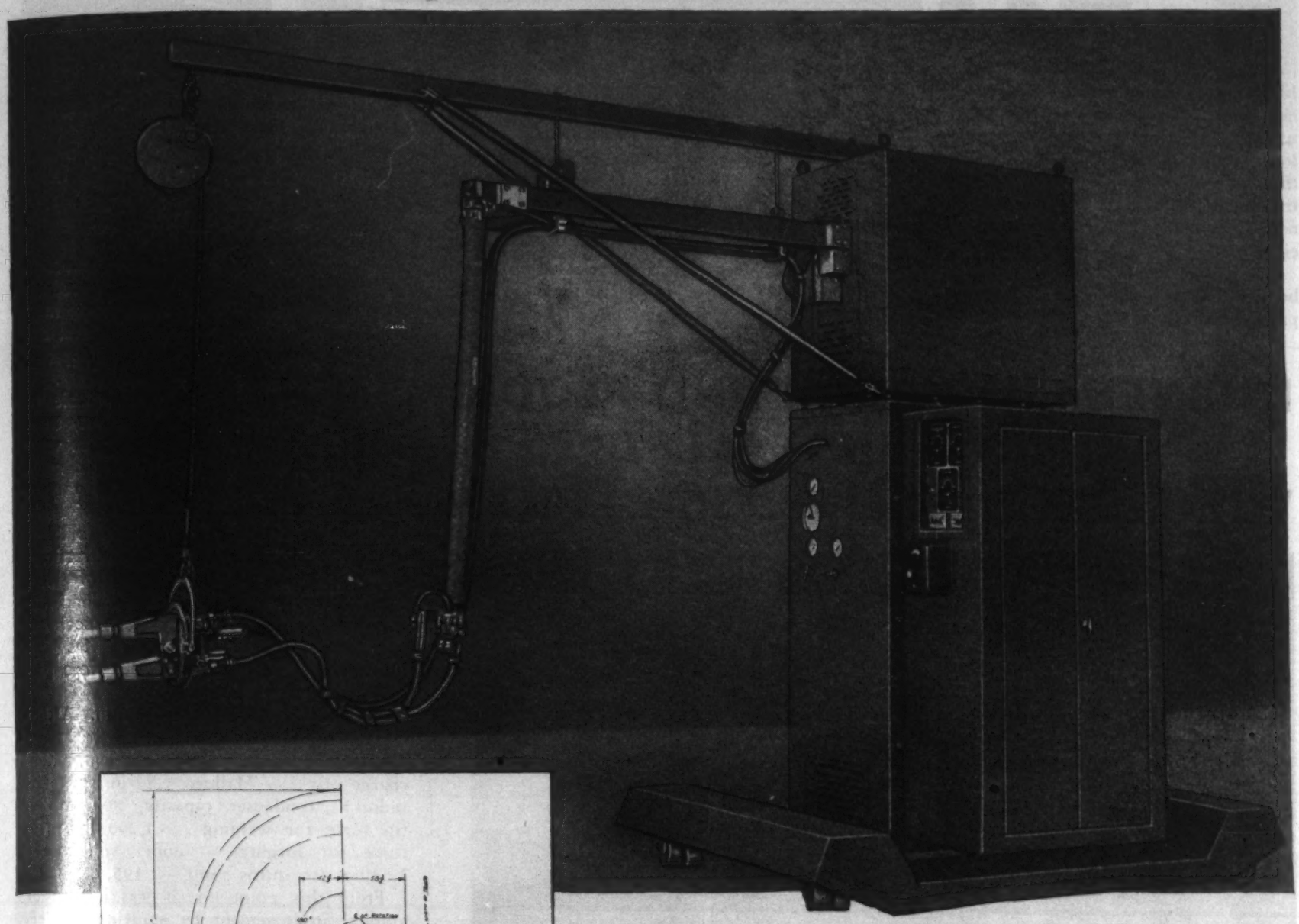
Solid particles of any material that is not affected by chromic acid plating solutions may be floated on the surface of the plating solution to reduce spray loss. The particles should be large enough to detach readily from the plated surface by gravity. Rods of the thermoplastic material known as "polystyrene," 0.25 x 2 in. in size, have been used successfully.

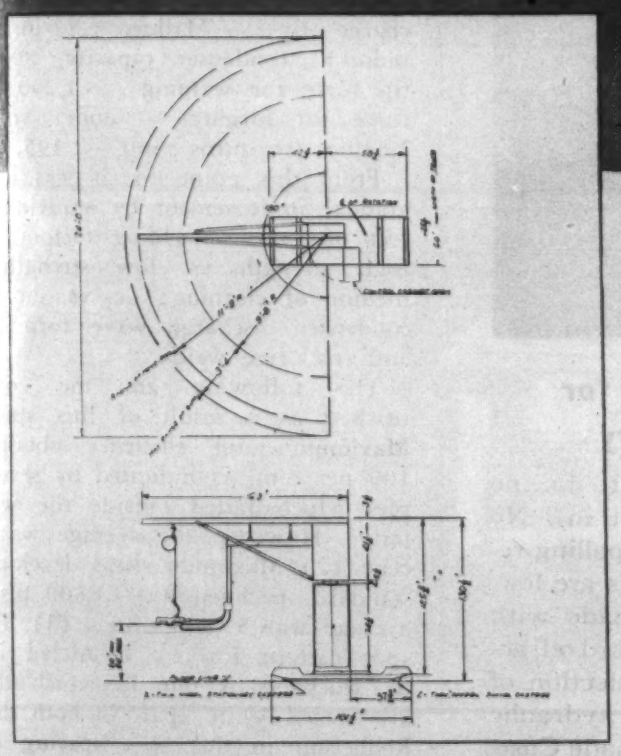
The effectiveness of the material in reducing spray loss depends on the thickness of the layer used. A single layer is not sufficient to make ventilation unnecessary. A thicker layer is more effective, but it is doubtful if enough can be used to make ventilation entirely unnecessary, because of the tendency of the gas evolved at the cathode to push the floating material away from this point. Nevertheless, spray is markedly reduced.

The most important effect of the floating "blanket" is the reduction in the amount of chromic acid lost as spray. A careful check on a bath operated at commercial conditions showed that more chromium was lost as spray than was deposited on the cathode. The use of a single layer of polystyrene rods of the above size cut this spray loss in half.

—C. T. Thomas. *Mo. Rev.*, Am. Electroplaters' Soc., Vol. 30, Aug. 1943. pp. 720-724.

HELPING TO SOLVE TODAY'S WARTIME PRODUCTION PROBLEMS





Dimension drawing of Sciaky Type PS2R-1, 100 KW, Radial Portable Spot Welder, showing maximum reach of gun and 180° rotation. Capacity: Aluminum and light alloys in two thicknesses of .016" minimum up to and including .064"—corrosion resisting steels up to two thicknesses of .080".

it reaches your welding problems

This radial portable spot welder for aluminum and light alloys will fill a long felt need in the fabrication of light structures. Sciaky engineering now makes it possible to bring the advantages of aluminum spot welding *to the assembly.* Crowded and fixed jigs can be easily reached. Tacking operations as well as structural welding can be accomplished with greater speed and efficiency.

Stored Energy with Preheating and Variable Pressure, features which are established as superior in the welding of aluminum, are employed. The control cabinet, main welding reactor, monorail and special copper bars connecting the gun to cables are all built as a self contained unit. This unit is mounted on a stationary column and pivots on a vertical axis by means of ball bearings mounted inside the column. Transversal movement of the gun on a straight line can be 12 feet in length. The gun may also be moved vertically 20 inches above and below a minimum position.

SCIAKY BROS.

Manufacturers of a Complete Line of
A.C and D.C Electric Resistance Welding Machines
4915 W. 67th Street, Chicago, 38, Illinois

Spot Weld Joint Efficiency

Condensed from an American Welding Society Paper

One of the design problems about which little has been published is that of the maximum efficiency of a multi-spot joint used for splicing sheets of aluminum alloy together. The major results of fairly thorough study of the factors that contribute to both high and low joint efficiency and to production economy are given here.

It was decided that the first step should be to determine the limits of spot spacing parallel to the joint as far as it affected sheet tension failure. This was to determine the ideal spacing and tolerances for the outer rows in a multiple row joint. Samples were made in which a patch was welded to a sheet using various spacings from ¼ in. to 1½ in. between spots. These were pulled in tension normal to the line of spots.

It was found that from ½ in. upward there was very little improvement in sheet efficiency. From ½ in. downward, the sheet efficiency dropped off rather rapidly. This test indicated a probable maximum stress of 60,000 p.s.i. and a joint efficiency of approximately 94 per cent.

The next step was to determine the minimum number of spots in the direction of load, which would be sufficient to insure failure by sheet tension. This was easily determined by a few simple calculations, which indicated that three spots of normal strength, parallel to the load, would be sufficient when the transverse spacing was ½ in. and the spot strength was 500 lbs. or better.

Minimum spot spacing parallel to the load at which no appreciable reduction in spot strength occurred was not studied. This was done by varying the spacing from ¼ in. to ¾ in., with the result that the minimum spacing appeared to be approximately ½ in.

Sufficient data were now available to make preliminary joints for efficiency tests. Specimens were made with the width varying from ½ in. to 3½ in. with the number of spots normal to the load varying from one to seven, the number of spots in the direction of the load equal to three, and spot spacing ½ in. in both directions. These indicated a sheet stress of from 48,000 to 57,000 p.s.i. at failure load, depending upon the width of the specimen.

It appeared that a width of 1½ in. gave the best results. These samples were prepared as follows:

Thickness of stock — .040 in. Alclad 24S-T; method of cleaning — wire brushing; type of machine — condenser discharge; tips — Mallory 3 (3-in. spherical radius); condenser capacity, 800 mfds.; tip force for welding — 1,200 lbs.; tip force for forging — none; voltage — 1,540 volts; turns ratio — 195.

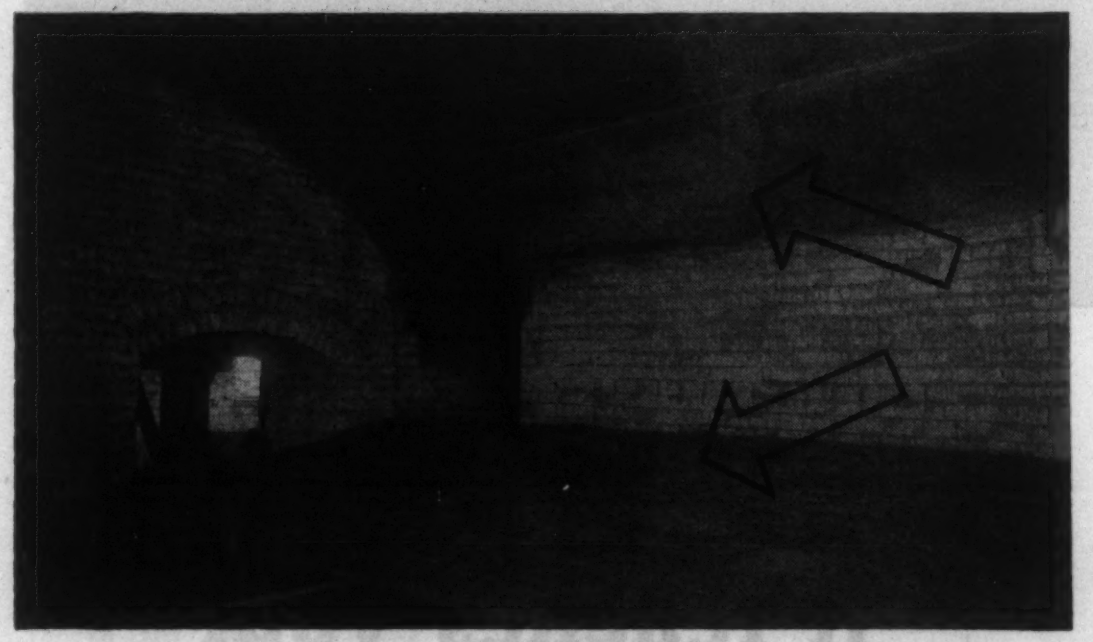
From this point on, it was a case of gradual improvement by studying the effect of various welding factors such as: high strength vs. low strength welds; method of cleaning; a.c. vs. d.c. current; condenser discharge wave form; cracked and crack-free welds.

The following are the conclusions reached as a result of this study: (1) Maximum joint efficiency obtained was 100 per cent, as indicated by several samples which failed outside the weld pattern. However, the average was 93 per cent. (2) Maximum stress developed on a standard specimen was 61,800 p.s.i. The average was 59,800 p.s.i. (3) The ideal spot pattern for 24S-T Alclad in 0.040 in. thickness is one in which the spots are spaced ½-in. apart in both directions. Reduction in this spot spacing is likely to result in a loss in strength of the joint. (4) Maximum efficiency is attained with a.c. welds.

(5) High-strength spots are better than low-strength spots for maximum efficiency and production economy. (6) Wire brushing is better than chemical cleaning. (7) The presence of small cracks, visible by X-ray only, is not critical. (8) Higher strength welds (free from small internal cracks) can be made with a.c. equipment than can be made with d.c. equipment. (9) For stored energy machines, current wave shape makes very little difference in joint efficiency.

—C. W. Steward, *Am. Welding Soc. Paper*, October 1943 meeting.

INCINERATOR ARCH AND FLOOR *QUICKLY INSTALLED* WITH CASTABLE REFRACTORY!



Another example of jointless refractory construction for tough service—with a LUMNITE Castable Refractory

IT'S QUICK AND EASY. Today that is an important advantage of a Castable Refractory. In jobs like the arch and floor shown above, the cast-in-place refractory, made with LUMNITE, is ready for service 24 hours after placing. Large jointless sections are as easy to cast as small precast units.

You buy the dry prepared mixture of refractory aggregates and LUMNITE to start with. You add water to the mixture, right on the job...pour it in a simple form. It is ready for service in 24 hours.

For walls, arches, floors, you get a one-piece refractory that prevents loss of heat and infiltration of air, and does not suffer from moisture or steam. There is no cutting or fitting to do...no ramming (you just tamp it in). No shrinkage to bother about. Spalling resistance is high. Upkeep costs are low.

A Castable Refractory made with LUMNITE gives you a balanced refractory, the result of careful selection of suitable aggregates and the hydraulic binder—LUMNITE—that made Castable Refractories possible. Different types of Castables meet different temperature and insulation requirements.

Refractory manufacturers sell them through their distributors throughout the country. The Atlas LUMNITE Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

Specify **CASTABLE REFRACTORIES**
MADE WITH **LUMNITE**

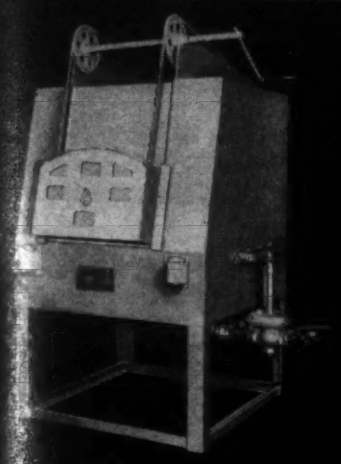
STEWART

THE BEST INDUSTRIAL FURNACES MADE

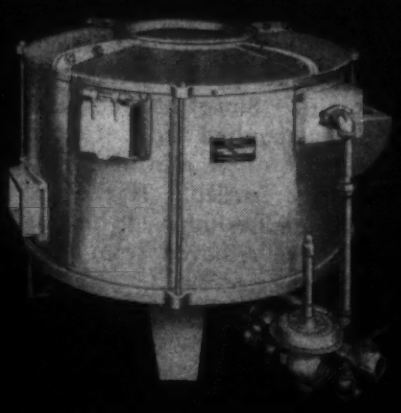
A TYPE FOR EVERY NEED

In addition to large units designed to meet specific production requirements, STEWART also builds these famous

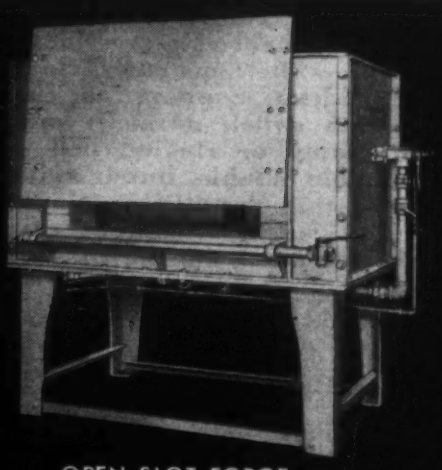
STANDARD INDUSTRIAL FURNACES



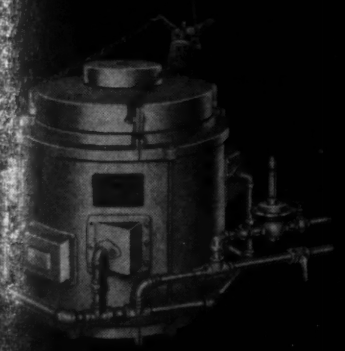
SEMI-MUFFLE OVEN FURNACE



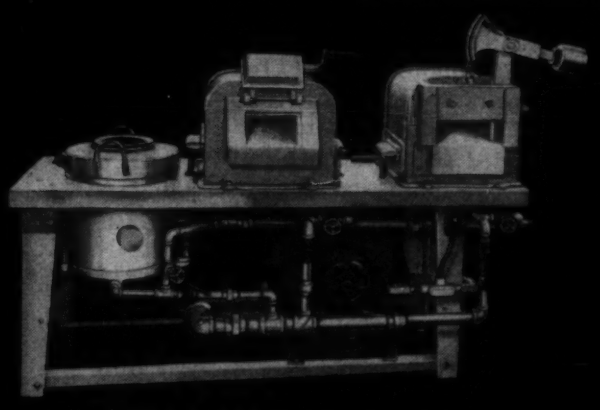
ROUND POT FURNACE



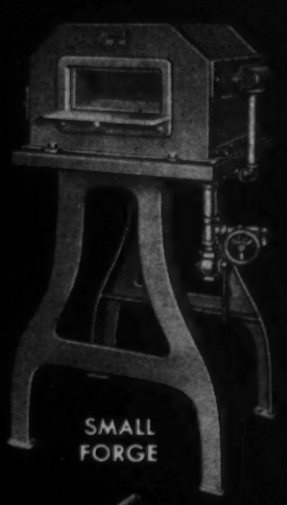
OPEN SLOT FORGE



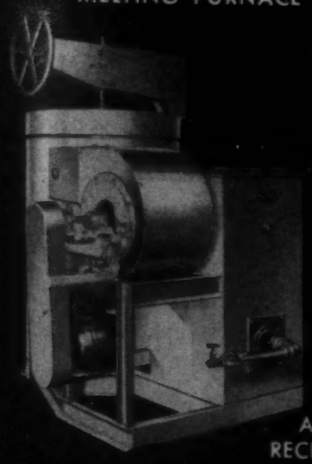
STATIONARY METAL MELTING FURNACE



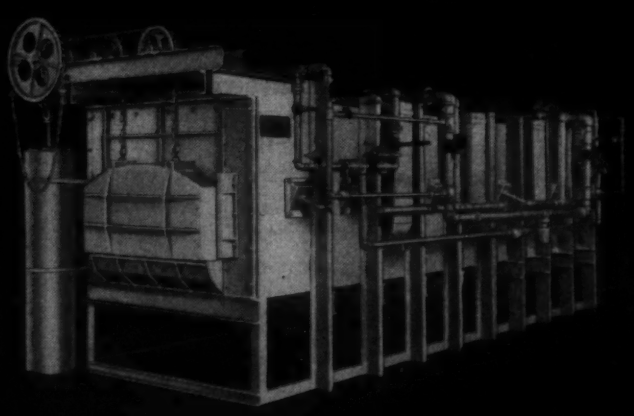
TRIPLE PURPOSE COMBINATION



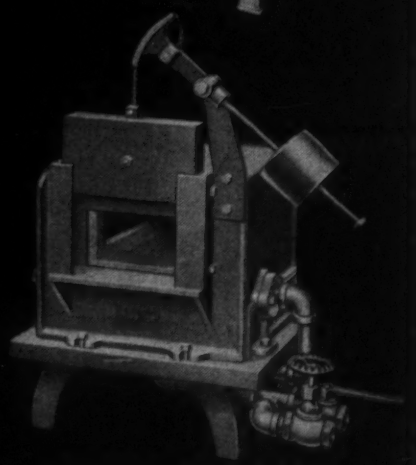
SMALL FORGE



AIR DRAW RECIRCULATING FURNACE



HEAVY PORTABLE OVEN FURNACE



BENCH OVEN FURNACE

A letter, wire or 'phone call will promptly bring you information and details on STEWART Furnaces. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat-treating problems with you.

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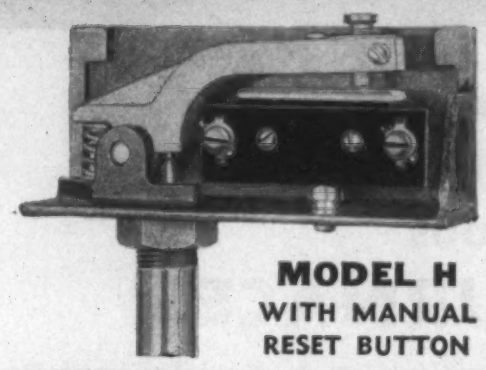
BURLING
TEMPERATURE LIMIT SWITCHES

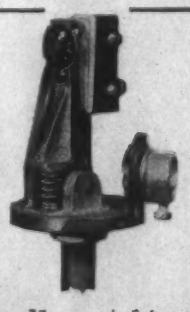


MODEL H
WITH MANUAL RESET BUTTON

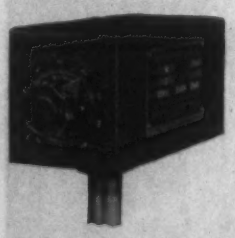
Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell — with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.

- **Accurate, Rugged, Dependable**
- **Corrosion and heat resisting tube**
- **Dial Pointer for easy setting**
- **Locking screw locks temperature setting**
- **Terminal plate has large screw terminals**
- **Snap-action Micro-Switch eliminates contact troubles**
- **Range 0-1400°F. Adjustable range 200-300°F**
- **Dimensions—5⅛" x 1¾" x 3"**

MODEL V-I



For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)



MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½x2¾x2¾").

Instruments also Built to Specifications

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Springfield Ave. at Livingston St.
Newark, N. J.

Aluminum Stretching

Condensed from "American Machinist"

Either 17-S or 24-S aluminum alloy may be stretched in the SO, SW or ST condition. However, in the case of structural members and stress carrying fairings which are so highly stressed that their ultimate condition must be ST, forming in either the SO or ST condition offers disadvantages. Sheets in the SO condition form beautifully, but show excessive distortion when water quenched in the subsequent heat treatment.

Slower quenches (air or spray) reduce distortion but also corrosion resistance. If the sheet is stretched in the ST condition, the form block must have the proper spring back allowance. Furthermore, it is impossible to form as deep draws in the ST as in the other conditions.

Standard procedure at Edo Aircraft, therefore specifies the SW condition. The sheet is rolled into 10-in. coils, water quenched from a salt bath, then immediately placed in a refrigerator at —10 to 0 deg. F. After the sheets are removed from the refrigerator, they remain soft for only 20 min. Since 12 min. is the maximum time required for stretching, there is a leeway of 8 min. before the sheet starts to age harden. If the sheets have not been used within 24 hrs. after quenching, they are removed from the refrigerator and retreated.

When the sheet is stretched in the SW condition, no allowance for spring back is necessary. Furthermore, no subsequent heat treatment is required, as the sheets develop full strength after 24 to 30 hrs. at room temperature. The only disadvantage of this procedure is that the cost is higher than when the stretching is done in the ST condition due (1) to the extra operations of coiling, heat treatment, and refrigeration; and (2) to the fact that the uncoiled sheets are not as flat as ST sheets and take more time for clamping.

Lubrication Important

Lubrication is very important. A good grade of automobile chassis semi-fluid oil or SAE No. 50 motor oil may be used. Extreme pressure oil does an excellent job but is too difficult to remove from the sheets. The lubricant is best applied with a brush. Both lubricant and brush should be kept absolutely free from grit and metal chips.

The only difficulty encountered in the actual stretching is with parts that have a great length to width ratio with a relatively small crown in their length and a severe crown crosswise. Then a bubble or "hat" section forms at the high point of the crown. The simplest method of avoiding such hat sections is by notching the ends of the sheet beyond the portion of the blank which is ultimately used in the finished part. Since heavy brown wrapping paper under load will behave exactly the same as an aluminum alloy sheet, provided its ultimate strength is not exceeded, trials can be made with wrapping paper to determine the exact position and size of the notches necessary to overcome the formation of the hat section.

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2. Longer Life for Electrodes—because incorrect dressing methods often remove too much of the electrode surface. Using a coarse file to dress spot welding tips, for instance, is wasteful. By machining tips on any small lathe equipped with a suitable collet or chuck, you can keep the amount of electrode material removed down to about .025" per dressing! Or you can use the Mallory Tip Dresser, a hand tool that does a quick machining job . . . with no need for removing tips from their water-cooled holders.

To assure longer electrode life, keep electrode surfaces clean. Use a fine abrasive cloth and a light, even pressure. It's better *not* to use an ordinary shop file, especially one that may be contaminated with iron filings, since iron particles imbedded in a copper-alloy welding electrode will tend to "burn" and pit the electrode —and the work.

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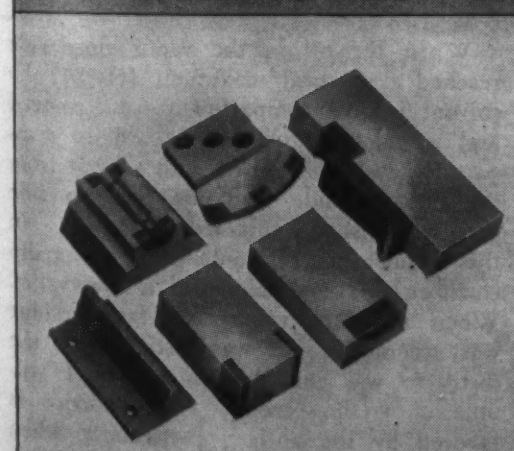	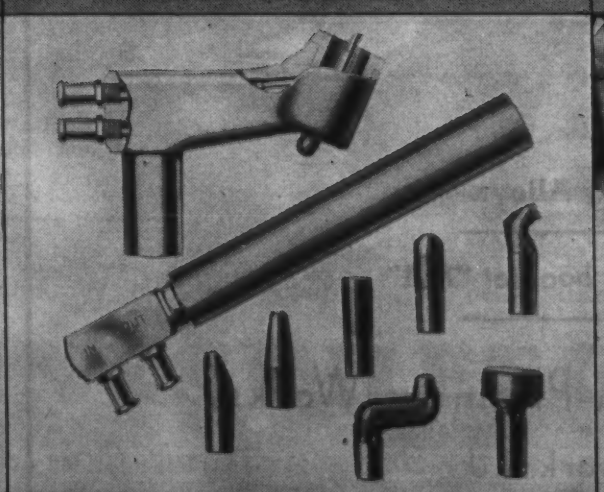	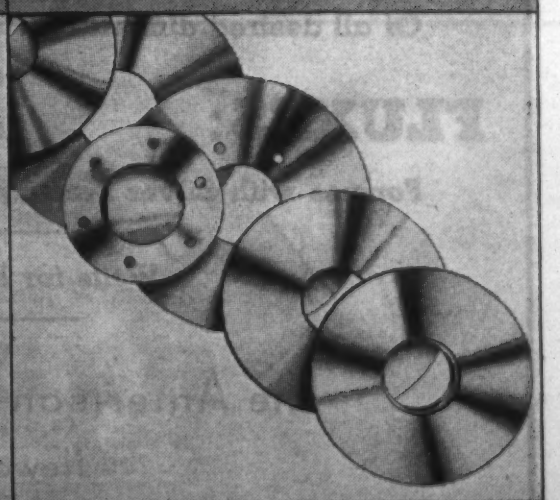

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tor in successful production operation of a stretch press is the clear establishment of a definite stretching procedure for each different form block. Stretching can also be done on annealed SAE 4130, 4345 and annealed and quarter-hard stainless steel. Although the use of the stretch press is now confined almost exclusively to the aircraft industry, post-war expansion doubtless will carry it into other fields such as automobile turret tops, spherical tank segments, fairings on streamlined trains, etc.

The low initial cost of the form blocks makes the process seem promising for experimental models. Although the largest finished sheet now stretched on a production basis is 18 ft. long by 4 ft. wide, machines will certainly be developed for larger sheets.

—C. L. Fenn, *American Machinist*, Vol. 87, Sept. 16, 1943, pp. 92-95.

Vapor Degreasers for Cleaning Small Parts

Condensed from "Metal Finishing"

In solvent-vapor type degreasers, using trichlorethylene as a solvent, work is usually immersed first in a hot dip, then in a cold dip, and finally in the vapor rinse, where the relatively cool work causes the hot vapor to condense on the parts. It is obvious that when the oil concentration has built up in both the hot and cold dip chambers, the vapor rinse must bear the burden of giving a product free of oil or grease. If the nature of the parts is such that they very quickly attain the temperature of the vapor (*i.e.*, if the parts are small and have a low ratio of heat capacity to surface area), then a sufficient volume of clean solvent will not be condensed on the work to rinse it thoroughly, and it will retain a grease or oil film.

Two different procedures are suggested for improving results in this situation. In the first method, the usual order of operations in running a degreaser is reversed. The cool work is hung in a basket in the vapor compartment. When condensation of vapor no longer occurs, the parts are removed from the vapor rinse compartment and immersed in the hot dip. It was found that while the oil concentration in the vapor rinse condensate compartment rose from zero to 60 per cent by volume, that in the hot dip seldom rose above 3 per cent and averaged 1.5 per cent.

When the oil in the vapor rinse side reached a practical maximum (60%), the solvent in this compartment was removed and saved for distillation. This compartment was then filled with solvent from the hot dip side, and the hot dip side was replenished with fresh solvent. In this manner, the oil content of the hot dip chamber was maintained at a low value. When sufficient vapor-rinse tank residue was accumulated, it was distilled and the distillate was mixed with an equal volume of fresh solvent. This practice is favored by the author, particularly when degreasing aluminum.

In the second method of operation it is suggested that the degreaser be operated in the conventional manner (*i.e.*, hot dip

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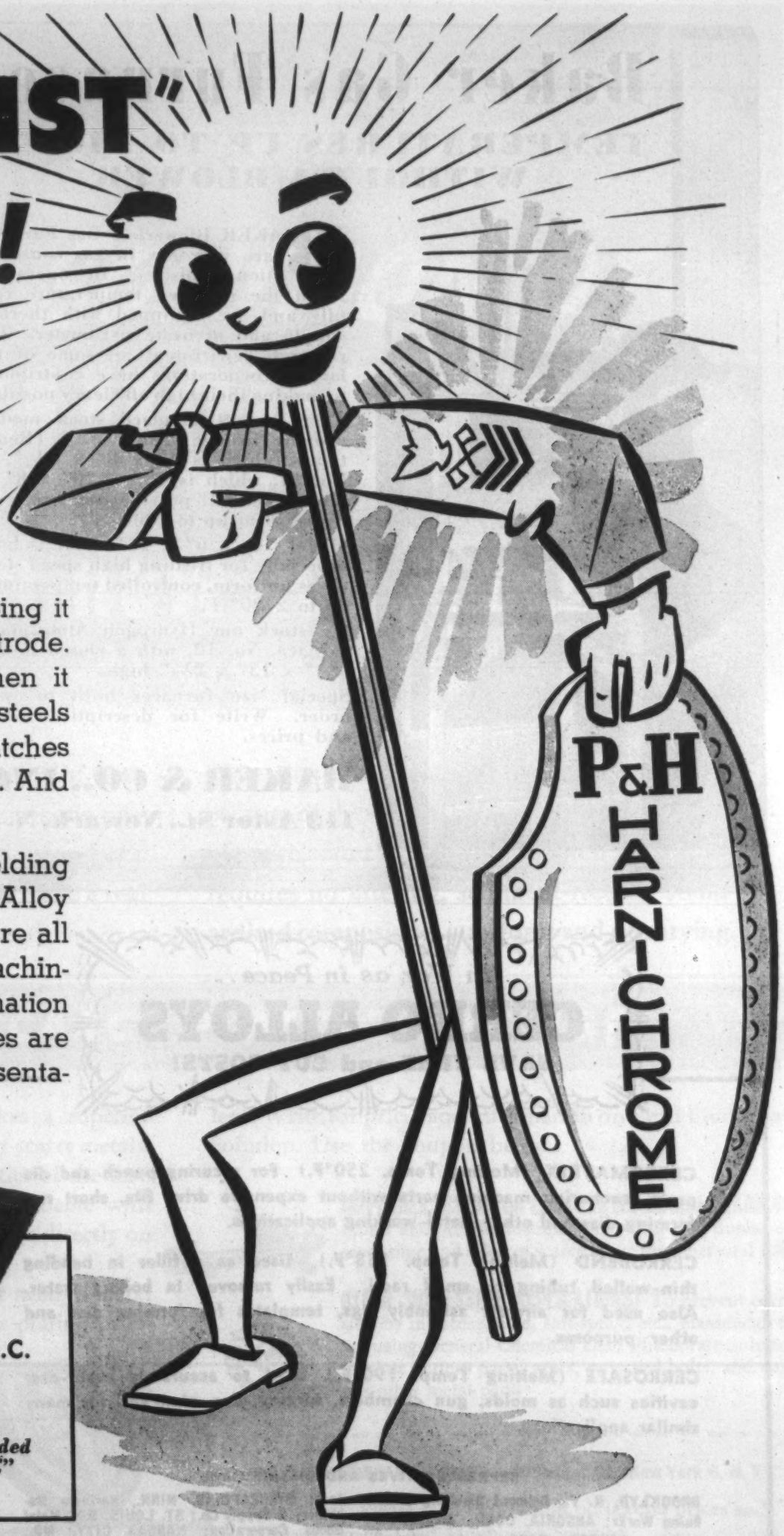

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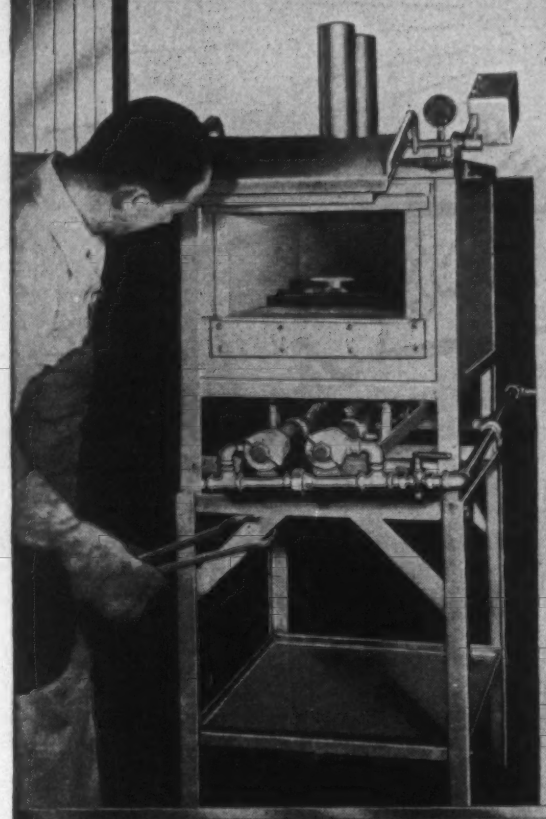

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followed by vapor rinse), but that the insufficient volume of solvent that the work itself is capable of condensing on itself in the vapor rinse be supplemented by vapor condensed on an auxiliary condenser located over the work.

In the design that is suggested, the condenser is portable and consists of a series of closely spaced finned tubes suspended immediately over the work basket. Vertical tubes leading to and from the condenser carry air or cold water as the coolant and serve also as an attachment for a hanger by means of which the condenser is suspended. With this device sufficient clean vapor should condense and run down over the work to free it entirely of grease or oil.

—B. D. Ostrow. *Metal Finishing*, Vol. 41, 1943, pp. 486-487.

Ordnance Flame Hardening

Condensed from an American Welding Society Paper

Peacetime heat treating facilities, even though completely converted, could not meet the overwhelming demands for volume work at the outbreak of the war. The answer to this deficiency was found in flame hardening and induction hardening.

A few months prior to this country's entry into the war, the flame hardening process had been expanded by the development of a new technique — simultaneous flame hardening and tempering. This new process was immediately utilized for ordnance heat treating, particularly on army tank bogie wheel rims. It is applied using the progressive method of flame hardening, with a multi-flame oxyacetylene burner, followed first by the customary water quench, then by a soft multi-flame oxyacetylene burner which heats the hardened wheel rim to a proper drawing temperature, thus producing the desired intermediate surface hardness. This paper describes and illustrates how this process is applied by a large welding company on a production basis, on bogie wheel flanges. Machines for hardening large wheels handle four at a time, and harden one wheel in eight minutes.

Another ordnance part which is hardened by the flame process on a production basis is army tank turret rings. These rings are hardened after finish machining, with negligible distortion and without need for subsequent machining or grinding. This job was put on a production basis without the usual developmental work, since the need for these rings was so great that the first rings hardened were promptly installed on tanks coming off the assembly line.

Since army field tests proved the advantages of flame hardened tank drive sprockets over unhardened sprockets, all tank sprockets are now specified to be flame hardened. The length of service of the hardened part is three to four times that of the untreated sprocket, whether they are flame cut from rolled plate or made of cast steel. Sprockets are hardened in various manufacturing plants by a variety of techniques, some of them being done manually, some semi-automatically, and some by machines which are largely automatic.

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Write for Bulletin WP 22.

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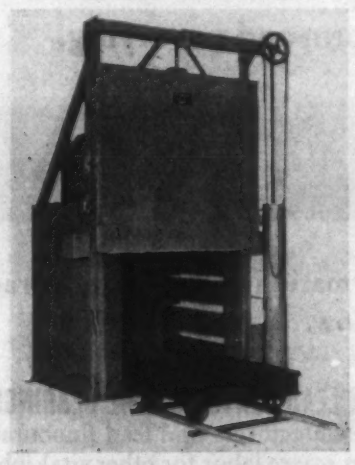

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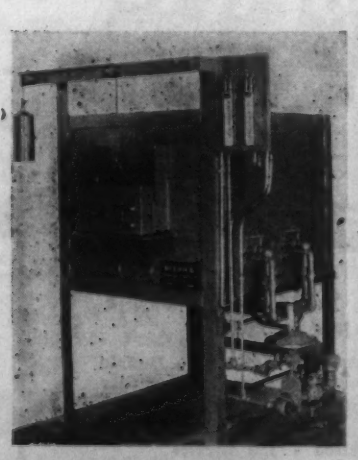

Full Muffle Furnace Atmosphere Control

Among the other ordnance parts which are flame hardened in large quantities are tank tread grousers, tractor roller hubs and tractor links. The grousers, 178 of which are required on each tank, are hardened on a production basis at one plant by the spot hardening method. Electric timers are employed for this and other operations to insure accuracy. The tractor parts are hardened at the rate of 25 rollers per hour, and for the link parts, 100 pieces per hour.

There are many other parts which are being flame hardened, including navy ordnance parts, but because of their confidential nature these cannot be revealed at the present time.

—Stephen Smith. *Am. Welding Soc. Paper,* October 1943 meeting.

Rust Preventives

Condensed from "Monthly Review," Am. Electroplaters' Soc.

Rust preventives containing the non-drying types of oils have a wide range of applications. Among their characteristics are: excellent protection; sufficient durability with economy; freedom from cracking and peeling from the metal surface; ready removal with petroleum solvents; and lubricating qualities, which make it unnecessary to remove them for many subsequent uses of the treated part.

In recent years many improvements have been made in this type of rust-preventive. These improvements include the development of types for special uses and the development of rust preventive addition agents which definitely inhibit rust formation. The following types are available:

Solvent type. This type contains a high percentage of Stoddard solvent as a vehicle for the grease and rust preventive. It is recommended for indoor protection against both humid and acidic atmospheres. It may be applied by dip, spray, brush, or swab, and covers about 1200 sq. ft. per gallon.

Fluid type. This type contains lubricating oil as the vehicle and gives somewhat better protection than the solvent type. It is useful for protecting small parts for indoor storage. It covers 650 sq. ft. per gallon, and may be applied by dip, spray, brush, or swab.

Plastic type. This type is suited for use on parts that are to be stored either inside or outdoors. The thickness of the film is sufficient to protect against the impingement of rain. This type can be poured at normal room temperatures but may be heated for ease of application. Application may be made by dip, brush, or swab. Dip application coverage is about 200 sq. ft. per gallon.

Solid type. This type is intended for outside use where severely corrosive conditions require a permanent, highly resistant, semi-hard coating. The film hardens slowly on the outside but remains soft and plastic next to the metal. It may be applied by dip, brush, or swab. When applied at 175° F., the coverage is approximately 80 sq. ft. per gallon.

—J. S. Norris, *Mo. Rev.,* Am. Electroplaters' Soc., Vol. 30, Aug. 1943, pp. 724-728

How automatic operation of Despatch furnaces assures better results, demands less skill

By eliminating manual effort in many operations, Despatch furnaces are helping non-ferrous heat treaters chalk up an amazing production record this year despite labor shortage. That's why, with 1944 slated as being more serious yet from the manpower standpoint, a Despatch furnace is an exceptionally valuable investment *now*.

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4 Materials and Engineering Design

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Creep Resistance of Boiler Tube Steels

Condensed from "The Engineer"

Creep resistance of steels varies with the structural conditions, but the effect on the creep resistance of varying the structural condition is not the same for all steels. However, of two conditions, such as those of tube and bar, one of these may have superior creep resistance. The extent of the superiority would probably be different for the various steels of this class.

Tests were conducted on a chromium-molybdenum type (Esshete CML) and on a ½% Mo type (Esshete D 4 C) superheater tube. Creep tests made on chromium-molybdenum steel were carried out at stresses ranging from 5 to 11 tons per sq. in. at 1000° F. Tests were continued beyond 40 days in order to determine the creep rate at this period. Results showed that creep stress values of the tube corresponding to creep rates 10^{-6} in. and 10^{-7} in. per in. per hr. are, respectively, about 25 and 10% greater than those of the bar material.

A specimen prepared from bar stock was tested at 7 tons per sq. in. at 1000° F. Comparison of the strain-duration curve on the bar shows that there is no size effect in the tests, the creep rates figures for the large and small diameter specimens being 5.97 and 5.92 by 10^{-7} in. per in. per hr., respectively.

Microscopical examination of the tube material showed a banded appearance consisting of small ferrite grains and areas of dense sorbitic pearlite with carbide particles precipitated at the grain boundaries within the grains. In the bar material, annealed at 940° C. (1720° F.), the grain size was definitely finer than that of the tube sample. The areas of dense pearlite were larger than in the tube sample. The coarser grain size of the tube is likely to be at least partly responsible for the enhanced creep resistance.

Creep tests were conducted on ½% Mo steel at stresses of 5, 9 and 13 tons per sq. in. over a period of 44 days at 896° F. Stresses corresponding to creep rates of 10^{-5} in. per in. per day showed 15.0 stress tons per sq. in. for the tube, while for the bar it was 14.6. The stress corresponding to rates of creep of 10^{-7} in. was 9.4 for the tube and 9.0 for the bar.

Microscopical examination of the tube showed uniform polygonal ferrite crystal structure with small areas of dense sorbitic pearlite and intermediate products. Examination of the bar, normalized at 940° C. (1720° F.), showed a uniform polygonal ferrite crystal structure, slightly banded with dense areas of sorbitic pearlite having a Widmanstätten appearance.

Results show, in so far as these steels are concerned, that when satisfactory tubes are manufactured and heat treated properly, the application of results of creep tests introduces a factor of safety of 25% for the chromium-molybdenum steel. Figures for the ½% Mo steel in bar form may be taken as directly applicable to corresponding tube material.

—J. A. Jones & W. E. Bardgett, *Engineer*, Vol. 176, July 2, 1943, pp. 6-8.

Plastic Pipe

Condensed from "Chemical & Engineering News"

Saran, a thermoplastic of the Dow Chemical Company, is a versatile plastic used for many things, including pipe and fittings.

The pipe, which is produced by a modified extrusion process, is similar in appearance to metal pipe. It is tough, durable, and has a high degree of resistance to corrosion and scaling, which makes it of value to the electrical, oil, gas, water and chemical processing industries. Typical properties are:

nominal size, in.	calc. lb./ft.	calc. bursting pressure, psi	working pressure, psi
1	0.475	970	190
2	1.09	620	125

It is easy to install as it is semi-flexible. Fittings, which are made by injection molding, come in standard sizes. Both blind and open pipe flanges have convex surfaces, which eliminate the use of gaskets. The pipe can be cut to size and welded on the job within 1 min. by using a portable nickel or chromium surfaced plate, which is heated to 400 to 500° F. The pipe ends are placed on the hot plate until a molten bead is visible; then they are pressed to-

TENSILE STRENGTH VS. WEIGHT

a quick comparison of plastics with common structural metals

MORE and more these days engineers are concerned with strength *per pound* rather than strength per unit area . . . which helps to explain why plastics are being specified more and more these days for structural applications that would once have gone to metals.

To give you a quick picture of how plastics compare with structural metals on this score, Table I presents data on the tensile strength-weight ratio of several Monsanto plastic materials typical of their class and of some common, stress-carrying metals; Table II compares the specific tensile fatigue of several representative plastics and metals.

The two tables together show up plastics in a surprisingly favorable light. As you might expect, duralumin is tops for specific tensile strength with alloy steels second—but third and fourth are two laminated plastics, both ahead of aluminum. When it comes to tensile fatigue-weight ratios you find the two top materials both embody plastics in their composition.

Obviously, data such as this is, at best, only illustrative. When you reach the point of actually specifying a material for a specific application you will want the most complete engineering data you can get on every material you are considering . . . data which is frequently hard to find on such new and widely varied materials as plastics. That's why it will pay you to remember these few facts about Monsanto:

1. Monsanto is one of the nation's largest manufacturers of plastics;
2. the Family of Monsanto Plastics is one of the broadest, most versatile groups of plastics offered by any one manufacturer;
3. Monsanto's plastics research laboratories and technical service staff are one of the best and most comprehensive sources you could find of engineering data on plastics.

To tap this mine of information when you need it, write: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

TABLE I

Tensile Strength-Weight Ratios for Plastics and Some Common Stress-Carrying Metals

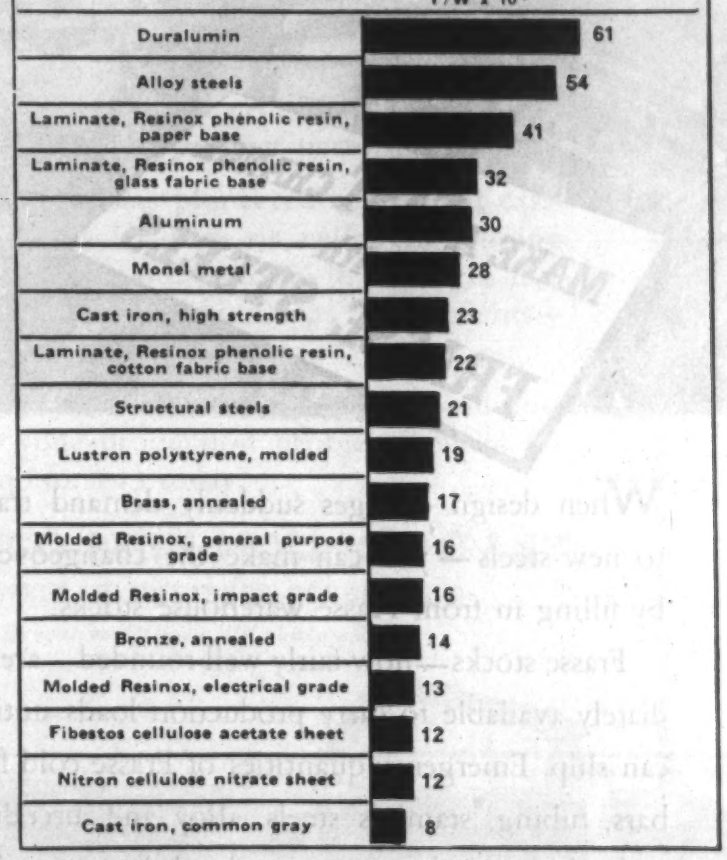
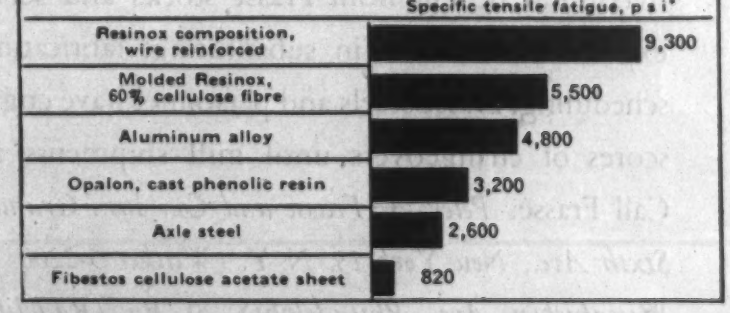


TABLE II

Tensile Fatigue-Weight Ratios for Plastics and Several Metals



*Tensile fatigue at 10^7 cycles/specific gravity.

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SAFLEX (vinyl acetal) . . . . RESINOX (phenolic compounds)

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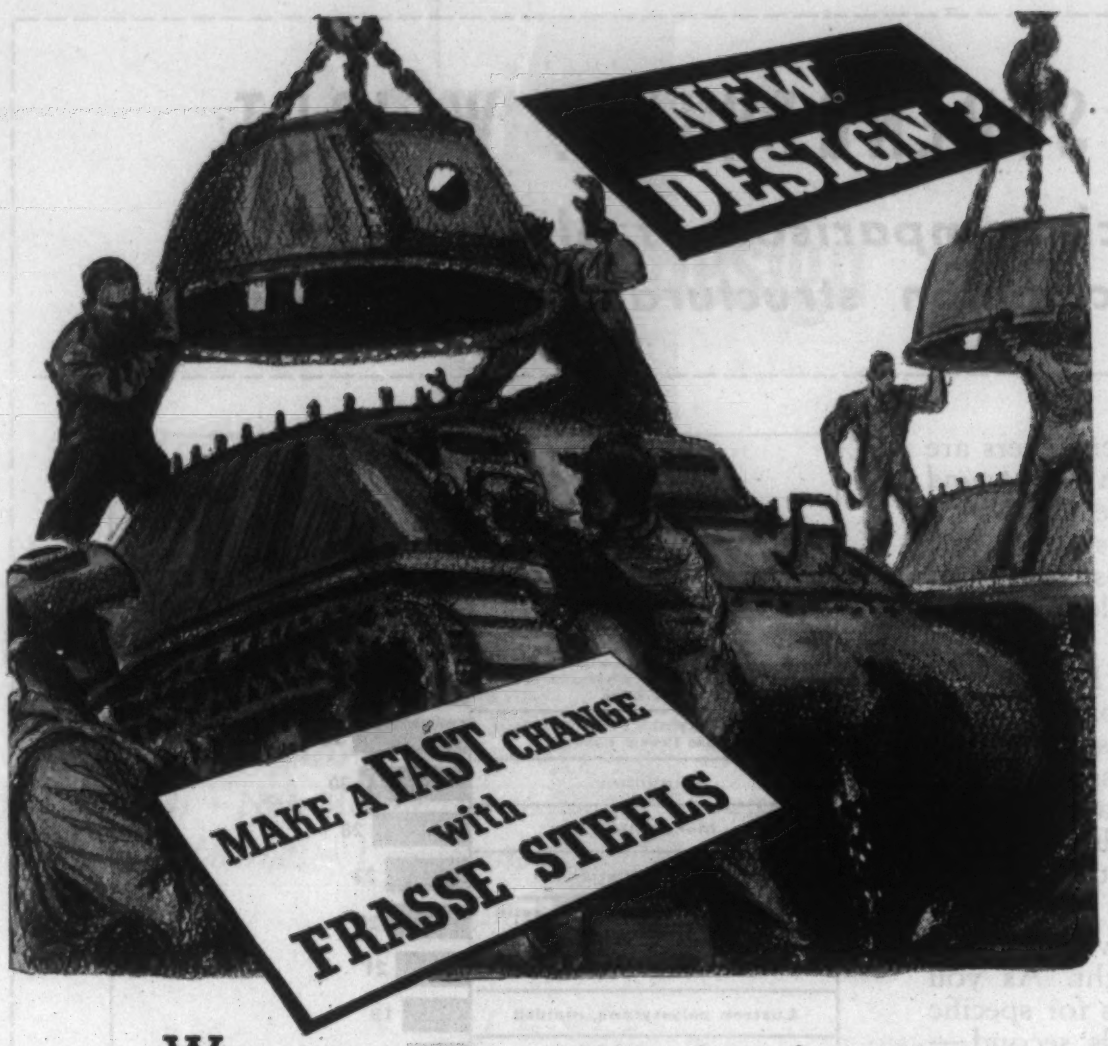
Vuepak Rigid Transparent Packaging Materials



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gether firmly in position and let cool. The resultant joint strength is equal to that of the pipe.

One of the newest applications involves the installation of nearly 4000 ft. on the heat exchangers for the rectifying units at the new Dow Magnesium Corporation plant in Michigan. The excellent electrical insulation of Saran prevents the 600 volt potential of the rectifier water jackets from being grounded through the heat exchangers to the river water piping system.

River water is used for cooling and may reach a temperature as high as 160° F. There has been so scaling or fouling, which would require dismantling of the whole rectifier. The life expectancy far exceeds that of the rubber pipe formerly used.

Saran sheet is used as an insulator to prevent the heavy leakage currents from the magnesium cells from travelling to the ground through the walls of the building. It is placed between the bricks of the walls, about 6 ft. above the ground, and between the metal joints and beams.

All indications point to an increasing use of Saran as a permanent part of electrical equipment, successfully replacing rubber. Not only are its corrosion and scale resisting, and insulating properties valuable, but it substantially reduces operating and installation expenditures. Important today is its reduced use of critical materials.

—*Chem. & Eng. News*, Vol. 21, July 10, 1943, pp. 1052-1053.

German Heat-Resisting War Steels

Condensed from "Stahl u. Eisen"

Heat-resisting steel castings have become of particular importance in power station machinery (*e.g.* steam turbines) and high-pressure synthesis. At present, air-hardened and comparatively soft molybdenum and chromium-molybdenum steels are used for this purpose up to 550° C. (1020° F.)

An exhaustive investigation was made to determine how far the amount of critical (strategic) material — molybdenum and chromium — could be lowered, with 82 steels of the following types: Stg 38.81, Stg 45.82, Stg 52.85, manganese, manganese-silicon, manganese-vanadium, silicon-vanadium, manganese - silicon - vanadium, chromium, chrome - silicon, chrome - manganese, chrome-manganese-silicon, chrome-vanadium (0.15V, 0.15-0.30V and higher), chrome-vanadium-silicon (0.15-0.30V and higher), chrome - molybdenum - vanadium, chrome-molybdenum, and molybdenum.

The results of tests for hot-embrittlement and weldability of alloy and plain steels, and of mechanical properties at room and elevated temperatures after different heat treatments, permit the following conclusions: For plain steel, a cast steel quality of at least 50 kg. per sq. mm. (71,000 p.s.i.) is sufficient for heat-resisting purposes. Manganese and chromium increase the creep strength only very little, and silicon has a limited effect only, and only at lower temperatures.

Of other elements, vanadium and especially titanium and columbium increase creep strength quite considerably. Manganese-vanadium and manganese-silicon-

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vanadium castings with 0.30% vanadium maximum creep strength values of 8 kg. per sq. mm. (11,400 p.s.i.) at 500° C. (930° F.), 13 kg. per sq. mm. (18,500 p.s.i.) at 450° C. (840° F.), and 19 kg. per sq. mm. (27,000 p.s.i.) at 400° C. (750° F.).

Chromium addition to unalloyed, to manganese and manganese-silicon steel castings had an improving effect on creep strength only above 0.5%, most notably at higher temperatures. Titanium-containing casting steels with additions of chromium or silicon have the tendency to become ferritic and thus lose hardenability; such melts are very brittle. In order to get the full effect of titanium, the hardening temperatures lie above 1000° (1830° F.), if possible at 1200° C. (2190° F.), which is difficult to control in mass production.

Titanium-containing steel castings are very notch-sensitive, but the toughness of unnotched specimens is very good. Columbium has the advantage over titanium of more liquid melts and less burning off, but the disadvantage that to bind carbon completely eight times the amount of columbium is required against four of titanium.

Long-time annealing without load showed that the modern steels do not develop hot-embrittlement. This tendency occurs only in cast steels with high chromium- and chromium-manganese contents. Tensile, creep and bending tests of welded specimens showed that the strength of the weld is equal to that of the base material, and only castings with more than 0.28% carbon develop a tendency to welding crack sensitivity.

—R. Schinn & R. V. Tinti. *Stahl u. Eisen*, Vol. 63, Feb. 18, 1943, pp. 125-133; Feb. 25, pp. 151-153.

Creep Resistance of Light Alloys

Condensed from "Aluminium"

With an especially-devised apparatus for the observation of creep behavior of light metals, five materials of the aluminum-copper-magnesium type (DIN 1713), three aluminum-zinc-magnesium alloys, and one aluminum-copper-zinc-magnesium alloys were investigated with respect to their time-elongation limit (0.2% permanent elongation in 200 hrs. loading time) in the temperature range 25 to 300° C. (75 to 575° F.).

Up to 80° C. (176° F.) the aluminum-zinc-magnesium alloys (after hot precipitation) possess the best mechanical strengths. For higher temperatures, however, the much higher heat strength of the aluminum-copper-magnesium alloys becomes evident.

Even for as low as 3% Cu contents, equally good creep strengths were observed in the latter alloys at average and higher temperatures. The copper-poor alloys, however, could not be brought by hot precipitation hardening to a high cold-elongation limit.

The time-elongation limit of an aluminum-zinc-copper-magnesium alloy was between the scattering ranges found for aluminum-zinc-magnesium and aluminum-copper-magnesium. A fine grain seems to be unfavorable at high temperatures for the creep strength.

—H. Adenstedt. *Aluminium*, Vol. 25, Jan. 1943, pp. 13-19.

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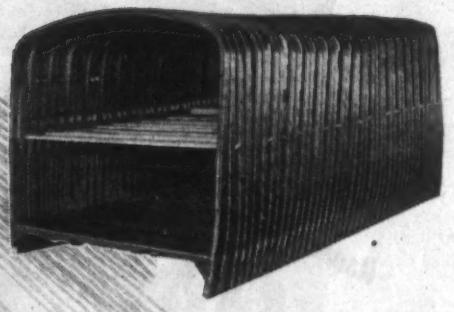

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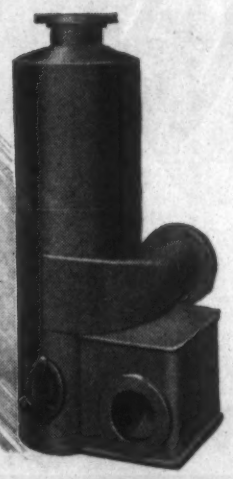

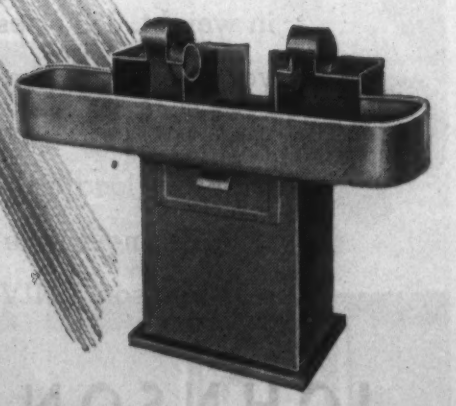

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Substitutes For Rubber Conveyor Belting

Condensed from
"Iron & Coal Trades Review"

Tests were made at Midland collieries on substitutes available for rubber conveyor belting. The types tried were belting containing no rubber and others containing some rubber. Most of the substitute belting tried is of solid woven impregnated cotton. Though there is some variation in the different makes, they are all solidly woven in one piece. There is also a slight variation in the weave of the different makes, depending on the manner in which binding threads pass around the weft.

Conclusions reached so far as regards all these types of belting indicate that, while not equal to rubber belting, they can be used with success provided: (1) Rubbing of edges is avoided as much as possible, as they do not resist wear like rubber and tend to fray; (2) they should not be used where conditions are wet; and (3) care should be taken with fasteners or hinges.

The common method of joining up the belt by reversing the engine while the rear portion of the belt is spragged is not suitable for this type. It is advisable to join up without using the engine.

A feature of solid woven belts is that they wear better than rubber. The ultimate life of these belts has not yet been determined.

Stitched ply impregnated belting consists of a number of plies machine-stitched and impregnated with bituminous material. Belts now on trial are of 5-ply formation.

The possibility of using hair belting appears remote because of the cost and supply of the material. It is strong and is made normally for transmission purposes.

Balata-type trial belting had a very low melting point, and when it got fast and slipping occurred at the driving drum, generated heat caused it to melt and the plies separated. This type was not satisfactory, and, in addition, the material is scarce.

It is claimed that steel wire mesh belts can be fitted to any standard flat belt conveyor without any alterations except that a sprocket wheel would replace the driving drum. The belt is known as blind mesh, *i.e.*, a square mesh with interstices covered by small plates to prevent dust falling through.

Other belting material up for consideration was that in which rubber is used as frictioning between the plies, but no top and bottom covers are provided. Still another material is similar to ordinary rubber belting, but with a rubber mixture in the covers and between the plies consisting of a small portion of natural rubber, the remainder being some artificial material.

Before the war there was available a type of solid woven cotton belting impregnated with latex. There were certain advantages claimed for it, especially in regard to resistance to tearing and surface wear.

—J. T. Barclay & P. L. Collinson,
Iron & Coal Trades Rev., Vol. 146,
June 18, 1943, pp. 917-921.

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Preventing Embrittlement Cracking

Condensed from "Transactions,"
Am. Soc. Mech. Engrs.

From the results of more than 900 plant tests a satisfactory method has been developed to prevent embrittlement cracking by means of an embrittlement detector, an arrangement that establishes under a test specimen the conditions that may cause embrittlement cracking in riveted seams, *i.e.* boiler water concentrated in contact with highly stressed metal. It is attached to the boiler and exposes the specimen to the boiler water in the same manner as a riveted seam may be exposed under operating conditions. The table gives an overall summary of the plant tests with the embrittlement detector.

Embrittlement cracking in a test specimen is invariably caused by an unsafe boiler water, but absence of cracking may be due to improper operation of the ap-

(Continued on page 1420)

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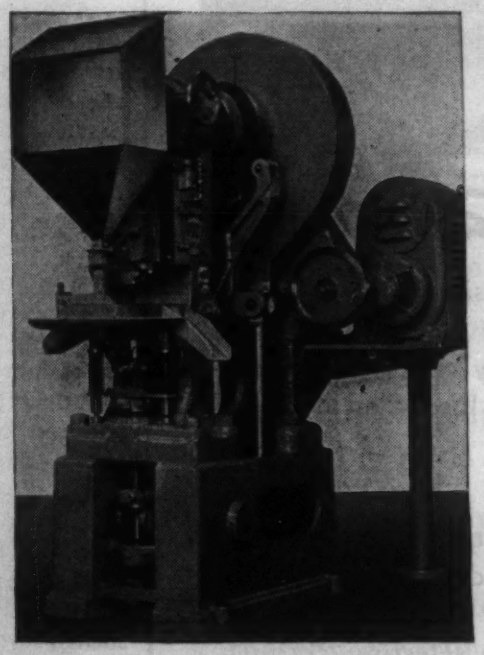

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F.J.Stokes AUTOMATIC TABLETTING EQUIPMENT FJS Est. 1895

Principal Inhibitor Present	Specimens Not Cracked	Ratio Recommended Inhibitor/Total Alkalinity	Specimens Cracked, Ratio Maintained	Approximate Useful Pressure Range
Sodium nitrate	117	0.3	0	
Sodium nitrate	88	0.4	1	
Quebracho extract	109	0.4	5	to 400 p.s.i.
Waste sulphite liquor	60	0.4	12	to 400 p.s.i.
Zero caustic alkalinity	8	caustic 0-8 ppm	0	to 700 p.s.i.
Miscellaneous	19	—	—	to 250 p.s.i.
No known inhibitor present in sufficient quantity.	184	—	286	to 800 p.s.i.

paratus. Sodium nitrate is relatively inexpensive compared with quebracho extract and phosphate but, unlike these other substances, it does not affect the character of the precipitated solids and would, therefore, not help to prevent formation of scale. Furthermore, its usefulness is not as yet determined beyond 400 p.s.i., as compared to 700 p.s.i. for quebracho and at least 800 p.s.i. for the treatment producing zero-caustic alkalinity. The lignin compounds are inexpensive but inferior to nitrate and quebracho, which have largely replaced the former.

Sodium nitrate and quebracho extract have stopped the embrittlement cracking of highly stressed steel specimens in embrittlement detectors on operating boilers. The maintenance of definite minimum ratios of concentration of these chemicals to the concentration of total alkalinity was required. By reducing the concentration of caustic to approximately zero, the need for an inhibitor was eliminated. Sodium phosphate alkalinity was successfully substituted for caustic alkalinity to achieve this purpose.

—A. A. Berk & W. C. Schroeder. *Trans.*, Am. Soc. Mech. Engrs., Vol. 65, Aug. 1943, pp. 701-711

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New Copper-Free Aluminum Alloys

Condensed from "V.D.I. Zeitschrift"

A great disadvantage of aluminum-copper-magnesium alloys, which in later years have found wide application especially in the construction of airplanes, is their comparatively low corrosion resistance. Experiments were made to find in how far aluminum-zinc magnesium alloys can replace the former, and what their corrosion resistances is. It was found that aluminum alloys with 4 to 6% Zn and 2 to 4% Mg are not only a fully equivalent substitute material for the copper-containing alloys, but have improved mechanical strength.

Proper zinc and magnesium content, the addition to alloying elements suppressing stress corrosion, and special heat treatment practically eliminate all the defects that at first occur in aluminum-zinc-magnesium alloys. As the raw material will always contain some copper, which impairs the corrosion resistance, it is quite possible to use such alloys in composite materials that are covered with pure aluminum-zinc-magnesium; the copper in the core acts as a strength-increasing element.

Practical experience has shown that a conversion of production of the copper alloy to the zinc-bearing one is not difficult, though some production stages might have to be adapted better to the special properties of the latter.

Two principal alloys are used at present: Constructal 20.42, with about 4.5 Zn, 2.5 Mg, 0.8 Mn, up to 0.8 Si and 0.5% Fe, the rest aluminum; and constructal 20/53, with 5 Zn, 3 Mg, 0.8 Mn, up to 0.8 Si and 0.5% Fe, the rest aluminum. Small copper contents of a few tenths of a percent can be considered admissible. The former alloy is mainly used for semi-finished materials, subject in the plane to strong deformations,

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as sheets, rivets, and for forged and die-forged parts; the latter material is for particularly high-strength profiles.

The mechanical strengths correspond in the cold-precipitated condition about to alloy Flw. 3115, with 3.7 to 4.7 Cu, 0.4 to 1 Mg, 0.1 to 0.7 Si, 0.3 to 0.7% Mn, and in hot-precipitated condition to Flw. 3125, with 3.5 to 4.5 Cu, 0.9 to 1.5 Mg, 0.2 to 0.9 Si, 0.9 to 15% Mn, the balance aluminum.

The mechanical strength of the second alloy, especially in hot-precipitated condition, is still much superior to Flw. 3125. The effect of cooling velocity on stress corrosion of sheets can be seen from the following table:

Annealing temperature	Number of cracked specimens after	
	water quenching	delayed cooling
480° C. (895° F.)	11	0
430° C. (800° F.)	7	0
380° C. (715° F.)	1	0

—P. Brenner. *Z. Ver. deut. Ing.*, Vol. 87, Feb. 20, 1943, pp. 105-109.

New German Aircraft Alloy

Condensed from "Aluminium"

The search for an aluminum-magnesium-zinc alloy, which in every respect could replace the airplane alloy (German) 3115, and omit the strategic copper experiments, led to an aluminum alloy with 3.5% magnesium and 4.5% zinc. The mechanical properties of this metal were then systematically investigated.

It was found that additions of chromium, copper and manganese increase strength very much, chromium giving the greatest and manganese the least effect. Vanadium has practically no influence on the mechanical properties. Cold-precipitation hardening extends over very long times; it is not yet complete after 150 days, although the changes are then only very small.

An increase of 10° C. (18° F.) in the temperature range of about 10 to 50° C. (50 to 120° F.) produces an increase of tensile strength and elastic limit of 1 to 2 kg. per sq. mm. (1400 to 2800 p.s.i.). Cold-precipitation hardening starts with a distinct incubation time of about 45 min.

An effect of solution treatment temperature on the mechanical properties was not observable between 400 and 500° C. (750 and 930° F.), and also the duration of annealing varying within the usual limits was without influence at 440° C. (820° F.). As cooling in air does not always give sufficient values, quenching in water is preferable. The soft-annealing temperature is 320° C. (610° F.).

Cold-deformation impairs cold-precipitation hardening. The increase in tensile strength and elastic limit obtainable by ten days storage is largest in sheets without cold-deformation, and with increasing cold-deformation the precipitation hardening process deteriorates more and more so that with 50% cold-deformation only 2 to 3 kg. per sq. mm. (2800 to 4200 p.s.i.) could be gained by cold-precipitation as against 11 to 12 kg. per sq. mm. (15,600 to 17,000 p.s.i.) in soft sheets.

—H. G. Petri, G. Siebel & H. Vosskühler. *Aluminium*, Vol. 24, Nov. 1942, pp. 385-389.

Zinc Corrosion in Salt Solutions

Condensed from "Korrosion u. Metallschutz"

Strips of zinc alloys of the 4 per Al, 1 Cu and the 1% Al types were subjected, in polished and nonpolished condition to corrosion in artificial sea water of pH 6 and 8, in 3 per cent sodium chloride solution and in the same solution with addition of 0.1 H_2O_2. The tests were made in a stirring vessel and two alternate dipping vessels with short and long dipping time, and in a spray chamber.

Great differences in corrosion were found, depending on corroding liquid, method of testing, type of material and surface quality. Such differences, however, did *not* occur in the corrosion tests in artificial sea water, the results being very uniform. It is recommended to use artificial sea water for the corrosion test of zinc.

—G. Wassermann. *Korrosion u. Metallschutz*, Vol. 18, Jan. 1942, pp. 21-25.

Even while your plant is producing war equipment on an all-out basis, your engineering department is probably designing equipment right now for the post-war market — equipment with vital parts that must be safeguarded by a wise selection of metal.

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Spectrographic Analysis of Alloy Steel

Condensed from "Steel"

To increase output by speeding up the analytical control in the production of alloy steels, Bethlehem Steel Co. has installed a spectrographic laboratory at its plant in Bethlehem, Pa. It furnishes the control and final heat analyses for 15 melting units producing alloy steels.

All constituents are analyzed spectrographically except carbon, sulphur, phosphorus and certain ranges of other elements. Over 5000 determinations are made each week. The steels analyzed have narrow specification limits with a large percentage of the concentrations in the higher alloy ranges.

The excitation source equipment consists of a high-voltage interrupted spark circuit and a high-voltage alternating current arc circuit. All controls and meters are arranged to permit maximum ease in operation. Spectrum exposures are timed automatically.

A standard Bausch and Lomb large Littrow spectrograph is used. A leather hood covers the plate holder and extends into an opening in the wall leading to the darkroom so that a plate may be inserted from the darkroom. Plates are developed in a machine equipped with automatic temperature control and two-directional agitators, operating out of step and with different oscillating periods. A plate is processed in about 3 or 4 min.

The microphotometer is so easily operated that the operator can make all readings with little shifting of position. The viewing screen and the density scale are so arranged that practically no adjustment in the accommodation of the eye is required in shifting the gaze from one to the other.

Procedure

Readings for the iron reference line and the element line are referred to the calculating board on which has been plotted the characteristic curve for the particular plate. The logarithmic ratio of the intensity of the two lines is determined in the usual manner. The lower scale block then is moved so that the zero point is under the hair line. The hair line is moved to a position corresponding to the density of the element line.

At this position the value read under the hair line is the logarithmic ratio of the intensity of the two lines. The hair line of the scale board is set to the same value and the concentration, in per cent, is read from the analytical scale above, which corresponds to the line originally read on the microphotometer. This permits easy reading of the analytical results from one of 40 scales, without inserting other scales or using sheets of analytical curves.

Each spectrum appears in two different densities. To obtain this effect, one half of the spectrographic slit is covered with a neutral filter that allows only 35 per cent of the light to pass. Lines too dark to read on the fully exposed part of the plate may be read on the other.

The laboratory is in continuous operation, with five operators on each shift. Samples (two cast pins) are sent by pneumatic tube to the excitation source room. A dome-shaped end is ground on each pin and they are inserted in the electrode clamps. After exposure a second operator, in the darkroom, removes the plate for developing and the spectrograph is reloaded immediately.

The developed plate is brought to the spectrum reading room, where there are three operators. The first reads the microphotometer, calling off the density values to the man at the calculating and scale board. He in turn calls off the results he obtains to the third man at the Telautograph. He is usually the foreman, and after scrutinizing for unusual results and determining if checks are necessary, he posts the results and reports directly to the various furnaces.

Analysis samples usually are reported in less than 15 min., and the results have been found to be as accurate as those obtained by the standard methods of chemical analysis. They are more accurate for some steels and certain elements and ranges, such a silicon in complex steels, molybdenum in tungsten steels, tungsten below 1.00% and most elements present in concentration below 0.20%.

—P. R. Irish, *Steel*, Vol. 113, Aug. 9, 1943, pp. 100-102, 105, 127-130.

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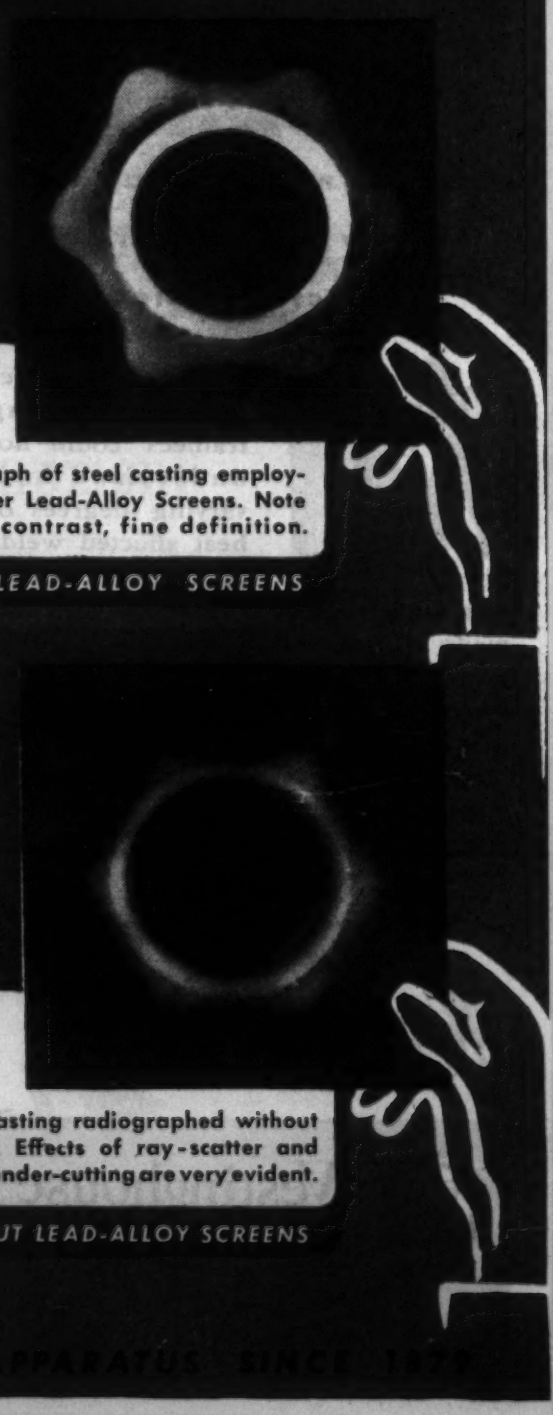
Sharper detail rendition . . . increased contrast . . . heightened over-all radiographic quality . . . these are the demonstrable benefits accruing to users of Picker Lead-Alloy Screens in industrial radiography. The striking difference evident in the examples shown here is due to the unique capacity of these screens for differential filtration, scatter-absorption, and intensification of the x-ray beam. The technique is simplicity itself . . . the film is merely placed between a pair of Picker Lead-Alloy Screens during exposure for consistently superior results.



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Spectrography of Cast Iron

Condensed from "Foundry Trade Journal"

This outlines a paper read before the annual conference of the Institute of British Foundrymen. The industrial spectrograph finds its greatest application in the routine analysis of steels, aluminum alloys and brasses. The industrial spectrograph covers a wave band of 2000 to 8000 A.U. (Angström unit $= 10^{-8}$ cm.). Alloys of the ferrous group give a spectrum containing so many lines that maximum dispersion is essential, hence the largest size instrument is necessary. The work was done on a large-size Hilger quartz spectrograph.

In this instrument, the band of 2000 to 8000 A.U. would give a spectrum of 30 in. long. A photographic plate of this length is impracticable, and the instrument is therefore so designed that the complete spectrum can be photographed in three sections of 10 in. Any 10 in. of the 30 in. can be utilized; throughout this investigation a band of 2700 to 4300 A.U. was used.

The spectrograph requires solid specimens (not borings) and these may be of any reasonable size and shape, but preferably about 1 cu. in. A piece of 1.2 in. diam. test bar is ideal. The mechanism of quantitative estimation by means of the spectrograph is as follows: The spectrograph splits up composite light from the spark, giving series of lines on the photographic plate. Each element present gives lines of definite and known wavelengths. By reference to wavelength maps it can be quickly determined if any element is present.

It has been found by earlier workers that the percentage of any one element, say manganese in cast iron, is determinable by the internal comparison method. This is simply the measurement of the blackness of any one line of the element compared with that of a chosen line of the major element within the same spectrum. In cast iron the major element is iron.

Most elements give many lines. Iron is profuse in this respect, giving about 10,000 lines within the range of this spectrograph. The first step towards quantitative spectrographic analysis is the careful preparation and chemical analysis of a series of samples covering the complete range of the element or elements to be determined spectrographically. The chemical analysis of these samples must be of the highest possible accuracy, since the value of the spectrographic estimation is completely dependent on this. It will be appreciated that all factors connected with the exposure, the plate itself and the details of development must be rigidly standardized.

When this investigation was commenced, spectrographic analysis was the only alternative to purely chemical methods. Since then, however, the Spekker Absorptionmeter has come into prominence, and it undoubtedly provides excellent methods for the estimation of elements which directly or indirectly give colored solutions. The estimation of manganese, for example, is speedy and accurate.

It can be safely assumed that both spectrographic and absorptiometric methods will be intensely developed in the near future.

—F. B. Ling, J. McPheat & J. Arnott. *Foundry Trade J.*, Vol. 70, July 22, 1943, pp. 233-239, 246.

Gaging Indium Bearings

Condensed from "American Machinist"

Lead indium plated master rod bearings present a difficult gaging problem. The lead indium plate is easily marred or scratched, and even finger prints leave tarnish marks. It is necessary to check the I.D. and O.D. in six places each, both before and after plating. Originally 4 hrs. were required to measure the I.D. with inside micrometers.

Now an Air-O-Limit gage is used to inspect the I.D. Only one gaging spindle is used for inspecting before and after plating. There is a control cabinet for cleaning the air and raising its pressure to 30 to 35 p.s.i. The compressed air is fed into the rear of the gaging spindle, passes through a restriction tube to prevent pressure fluctuations and thence to two orifices on opposite sides of the gage plug.

The clearance between each orifice and the adjacent bearing wall is 0.003 in. to avoid marring. The air gap so created restricts the free flow of air from the orifices; the back pressure is read on a dial, which is calibrated in tenths. Out-of-roundness is checked by rotating the bearing; taper is indicated by traversing the gaging spindle.

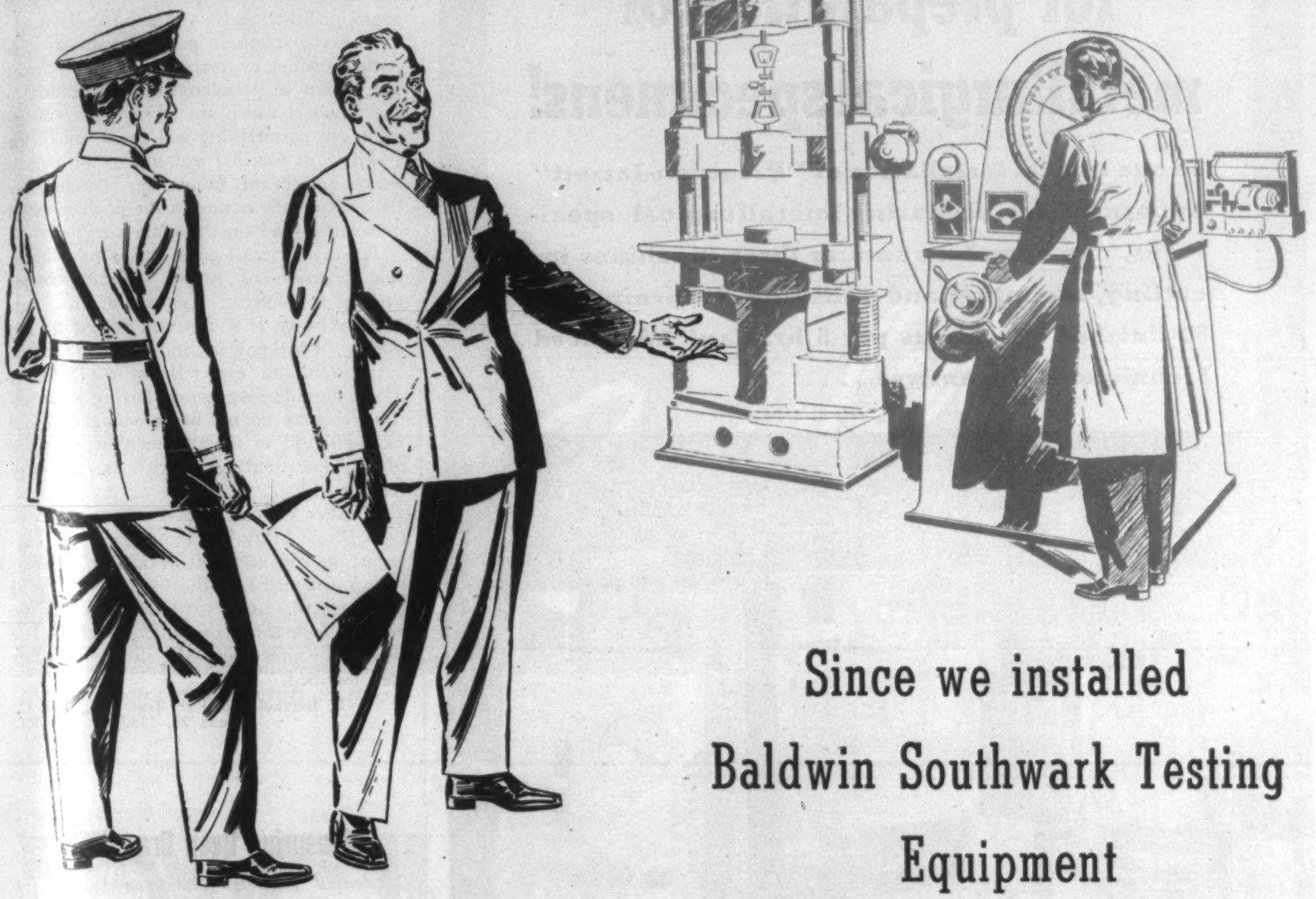
With this new system, the O.D. of the silver plated bearing is checked in six places with the Electrolimit gage, and the I.D. is likewise checked in six places but with the Air-O-Limit. On the basis of the averaged O.D. and I.D. readings, the bearing is placed in one of four categories: low I.D.-low O.D.; high I.D.-low O.D.; low I.D.-high O.D.; high I.D.-high O.D. A card indicating the category goes with the bearing to the plating department, where the plating time is adjusted accordingly.

After the bearing is carefully cleaned, it is lead plated in a fluoroborate solution with lead anodes, and then indium plated in an indium dextrose cyanide solution with platinum anodes. After washing, diffusing (2 hrs. at 340° F.), and degreasing, the bearing is reinspected as above. A slip giving the average I.D. and O.D. values is put in the bearing before it is sent to be stored.

The use of the Air-O-Limit gage not only avoids scratches, but is also at least five times faster than the use of inside micrometers.

—*Am. Machinist*, Vol. 87, Aug. 19, 1943, pp. 86-89.

NO GUESSING HERE



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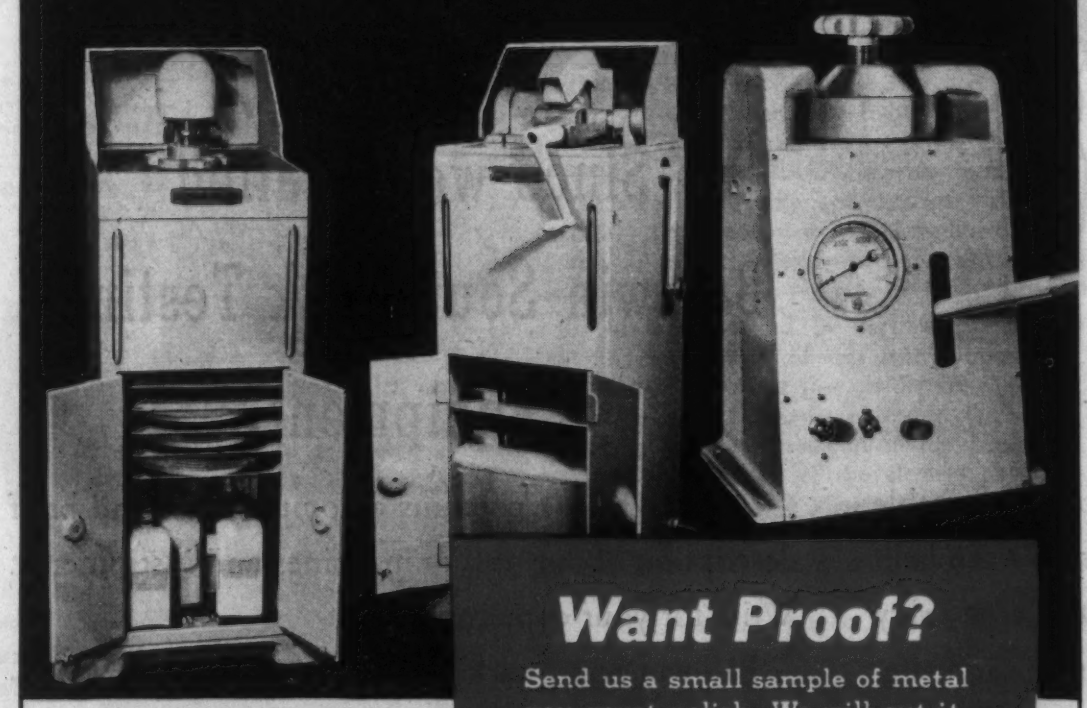

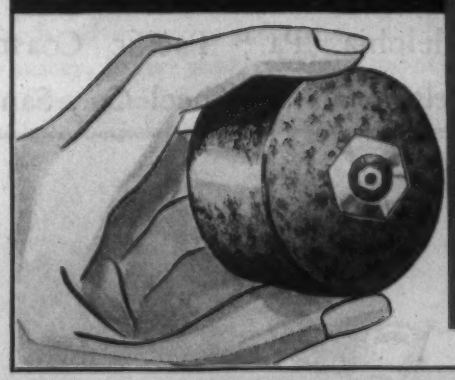

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Magnetic Powders for Testing

Condensed from "V.D.I. Zeitschrift"

For the non-destructive testing of materials, the magnetic powder test is now widely used because of its simplicity and sensitivity. In order, however, to get consistent results if the test is made by different observers a standard testing method has been developed (in Germany) to give reproducibility and comparison of tests.

The characteristic properties of a magnetic powder or magnet oil, *i.e.* powder suspension in petroleum or oil addition to the powder, which are taken into consideration are permeability and grain size of the powder, its settling velocity, color permanence and beard formation. Permeability depends on the nature of the powder (steel or oxides) and on the grain size.

Powder of small grain size is suitable for the detection of surface defects, coarser powder for defects in greater depths. Settling velocity is a function of grain size, density of the powder and the liquid of the suspension and especially of the viscosity of the liquid; suspensions having high settling velocity do not bring enough powder in the liquid to the specimen, while those of too low settling velocity are not very sensitive.

Whisker formation occurs in powder of high permeability and large grain size (aggregation and adhesion of magnetized particles), disturbing the result. Colored powders are used to better observe the powder formations on dark surfaces. The means for measuring the different factors are described.

—R. Berthold. *Z. Ver. deut. Ing.*, Vol. 87, June 26, 1943, pp. 399-401.

Measuring Deep Drawability

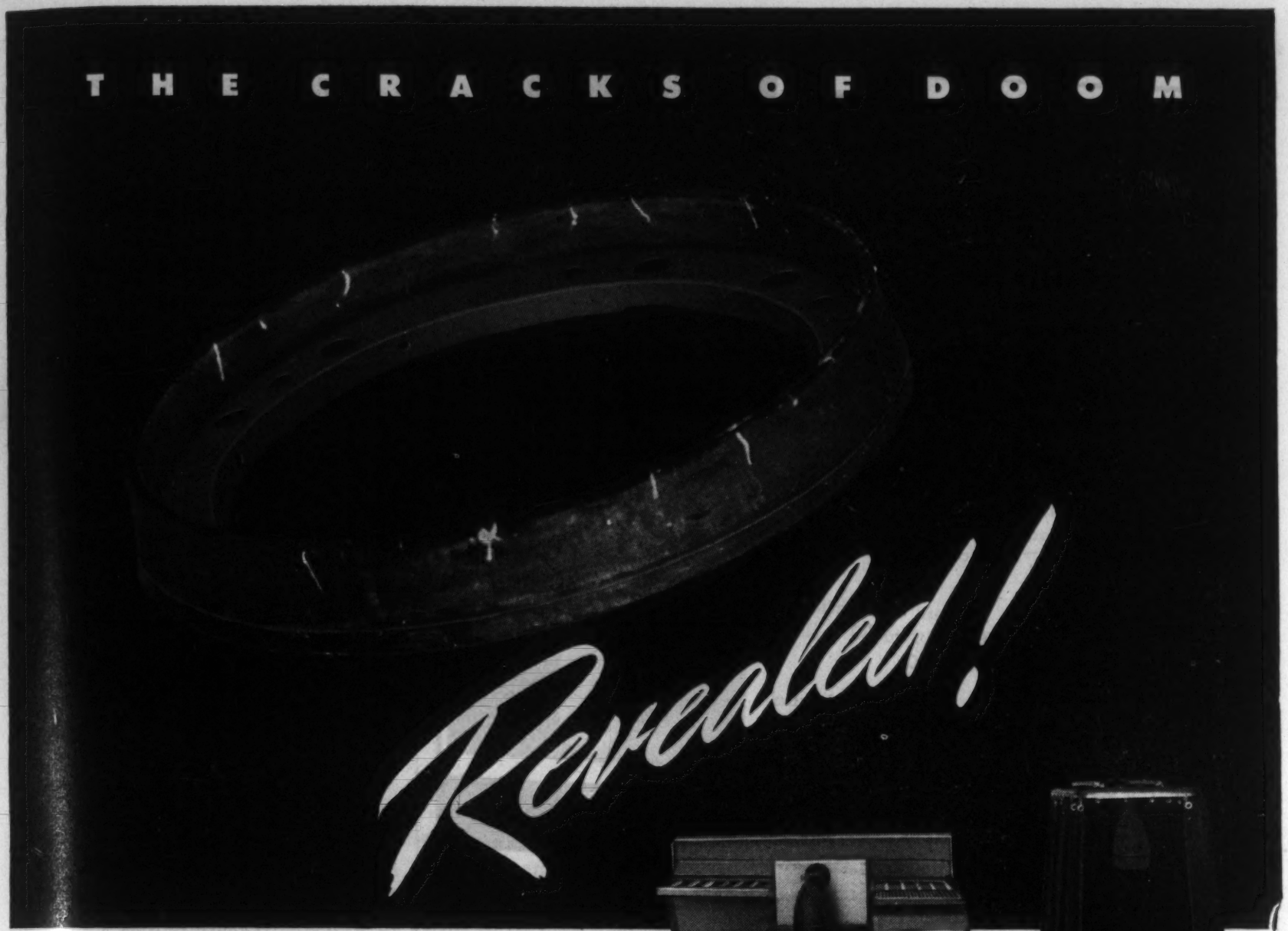
Condensed from an American Society for Testing Materials Paper

No mechanical test in use at present gives an entirely reliable indication of the behavior to be expected from sheet metal in deep-drawing operations. Present practice is to buy sheet steels on the basis of performance rather than specifications.

The properties of sheet metal which affect its behavior in deep-drawing operations are chiefly its rupture strength, its rate of strain hardening, and its ability to flow under the conditions imposed. The Olsen and the Erichsen tests fail to consider all of these factors. The wedge-draw test, although said to give good correlation with service performance, is not suited to routine testing.

A modification of the ordinary cupping test was devised to include bending and upsetting actions. A special die and punch, providing for drawing a cup of 1 in. inside diam. and height varying according to the size of the blank, are used in a punch press or testing machine. The index of drawing quality is that the maximum diameter of blank which can be formed, and the percentage breakage in that size. Different dies are used for different gages of metal, to keep the annular clearance constant. Tests on one machine at 3 in.

THE CRACKS OF DOOM



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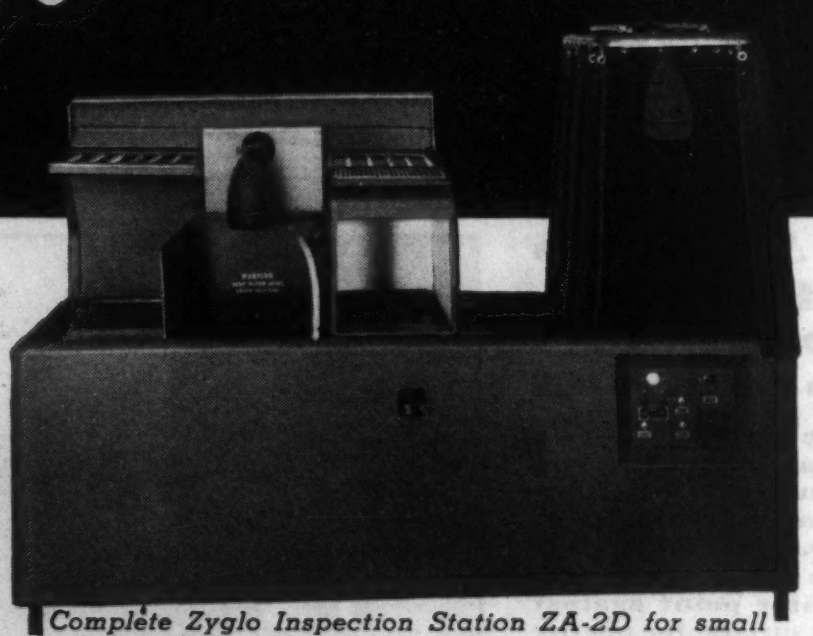
Shrinkage cracks in aircraft casting



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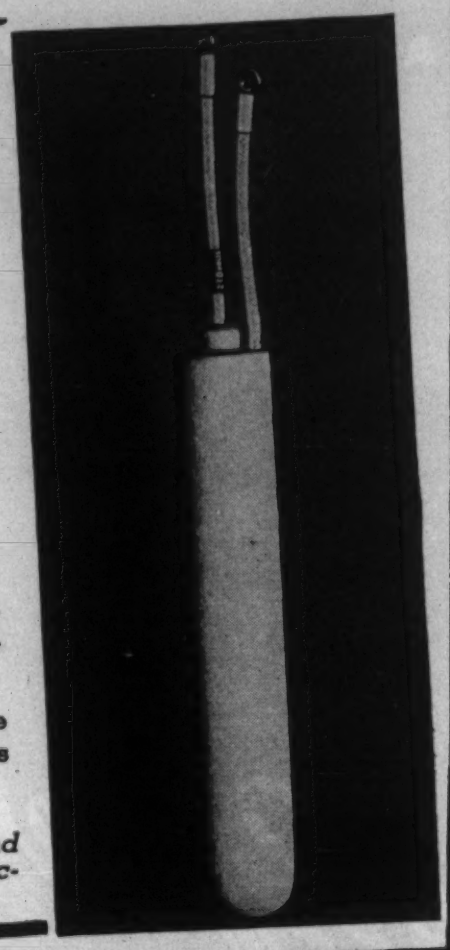

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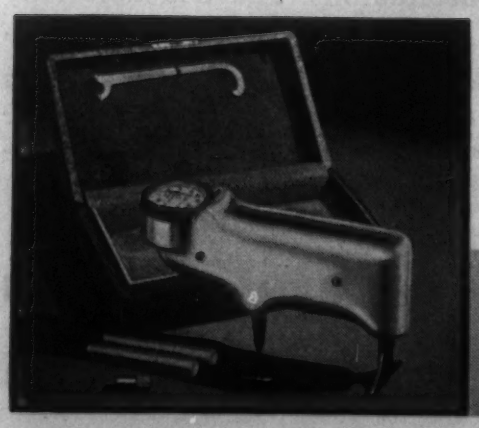

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per min. and another at 100 in. per min. were essentially identical.

Results showed that breakage figures were readily reproducible within 10 per cent, and that blanks about .03 in. larger than the critical diameter gave 100 per cent breakage, while those .03 in. smaller gave zero breakage. Fracture of the specimens was not due to the load, but to improper distribution of the stresses. Drawing loads had no value in rating drawability.

The cup-drawing index used in reporting results is made up of the critical size of the blank, and the percentage success in forming blanks of this size. The size is listed in 1/32-in. increments over 2 in.

While few samples with known service histories could be tested, these showed agreement between test results and performance. Samples of slightly varying chemical composition also showed cup-drawing index correlation as far as carbon and sulphur were concerned, but manganese, copper, and phosphorus, within the range studied, were without effect. Temper rolling lowers the cup-drawing index, particularly in the neighborhood of .75 per cent reduction.

—Francis W. Boulger & F. B. Dahle. Paper, Am. Soc. for Testing Materials, June 1943 meeting, 16 pp.

Treatment for X-Ray Film

Condensed from "Journal of Scientific Instrument

Although a film with an emulsion suitable for X-ray work coated on one side of the film is available, circumstances may arise requiring the removal of unwanted developed image from the one side of a double-coated film without damaging the emulsion on the other side.

It is more convenient to remove the gelatin layer containing the unwanted image completely. A 10% solution of sodium hypochlorite will remove such gelatin. This solution should not be left in contact with the skin for any length of time.

This method may be applied only to unwanted gelatin layer. The method is as follows: Blotting paper is cut to fit the bottom of a dish, which should be larger than the film. Sodium hypochlorite is poured into the dish until the blotting paper is soaked. The film is laid on the blotting paper with the unwanted image downwards, and a clean sheet of glass, about ½ in. smaller than the film, is laid on the film. A weight may be placed on the glass if the film tends to curl. In a short time the gelatin layer starts to disintegrate with evolution of nitrogen bubbles.

Care should be taken to prevent any solution from reaching the top surface of the film. The lower gelatin layer should be nearly destroyed in 3 to 4 min. To make sure, remove glass and lift the film. Flush the pad with fresh solution and lay the film down. The film may then be cleaned with water.

—G. W. W. Stevens, *J. Scientific Instruments*, Vol. 20, Aug. 1943, pp. 133-134.

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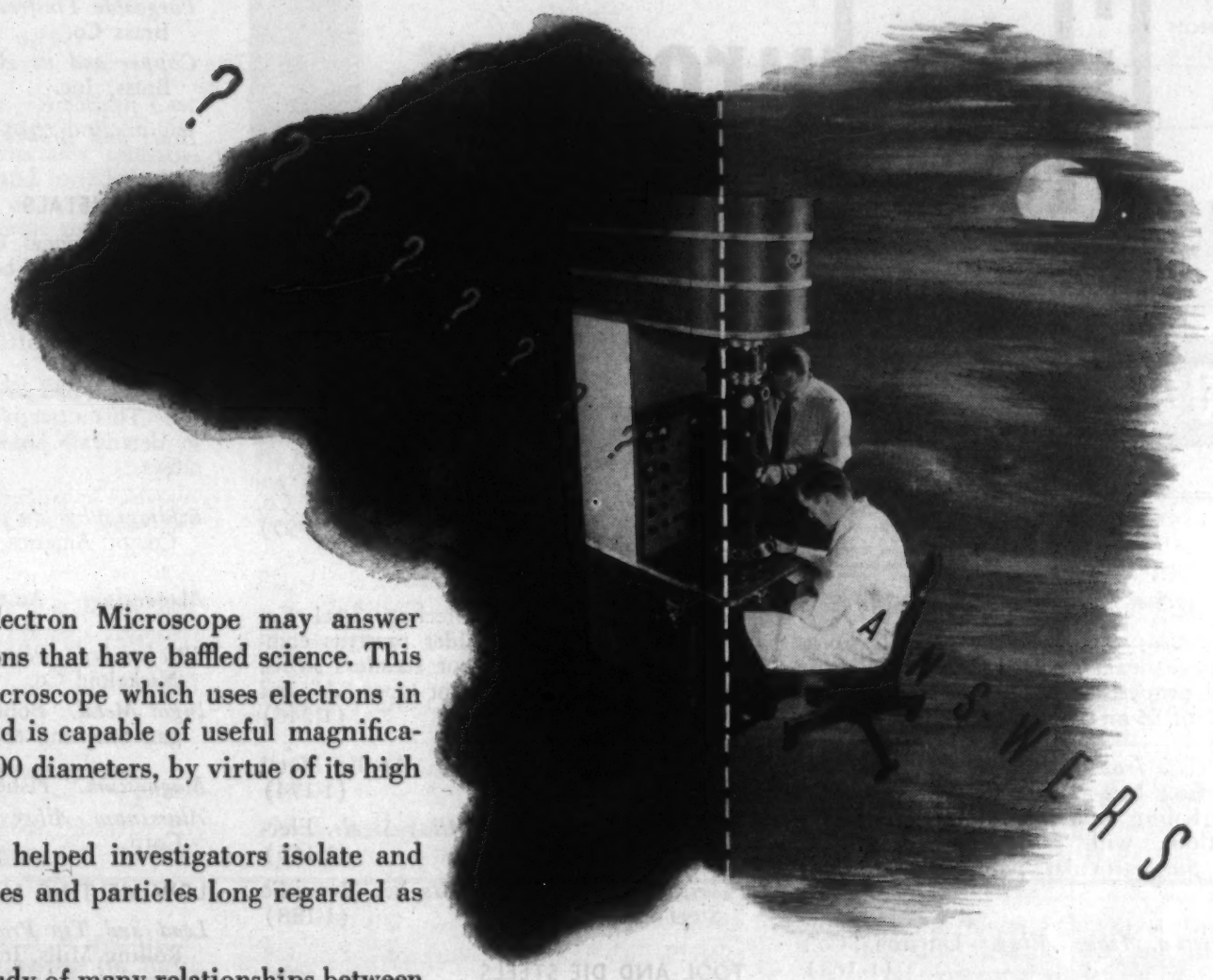

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Fabrication of Stainless Steels. Republic Steel Corp. (1-188)

TOOL AND DIE STEELS

Cemented Carbides. Carboloy Co., Inc. An attractive, 4-page folder illustrates how Carboloy cemented carbides aid in keeping up steel cutting production. (1-247)

Tool Catalog. Vascoloy-Ramet Corp. In addition to the listing of their Tantung tools, this highly illustrative, 24-page catalog, No. 227, presents valuable information on how to grind and braze Tantung and includes its performance data. (1-244)

Alloy Tool Steel. H. Boker & Co., Inc. (1-224)

Proper Tool Steel. Carpenter Steel Co. (1-219)

Tool Steels. Copperweld Steel Co. (1-228)

Tool Steels. Crucible Steel Co. of America. (1-193)

Rolled Composite Die Sections. Jessop Steel Co. (1-232)

2. Non-Ferrous Metals

COPPER AND ITS ALLOYS

Bronzes. Ampco Metal, Inc. Data sheet No. 117 presents the five applications of Ampco metal used in the Sikorsky helicopter. (2-239)

Bending Copper Tubes and Pipes. Copper & Brass Research Assoc. An informative, 80-page catalog presents complete data on methods and devices for bending pipes and tubes of copper and its alloys. (2-241)

Copper Alloys in the Aircraft Industries. American Brass Co. (2-158)

Oxygen-free Copper. American Metal Co., Ltd. (2-145)

Bronze Bar Stock List. Johnson Bronze Co. (2-175)

Forgeable Tin-free Bearing Metal. Mueller Brass Co. (2-165)

Copper and its Alloys. Revere Copper & Brass, Inc. (2-199)

Brass and Bronze. Titan Metal Mfg. Co. (2-102)

LIGHT METALS

Ingots. Samuel Greenfield Co., Inc. An attractive, spiral-bound booklet, 22 pages, covers aluminum, brass and bronze ingots in production, and includes a number of specification charts. (2-243)

Aluminum and its Alloys. Reynolds Metals Co. This attractive, 20-page bulletin covers in detail all phases of aluminum and its alloys. (2-240)

Bibliography on Aluminum. Aluminum Co. of America, Service Bulletin No. 1. (2-140)

Magnesium. American Magnesium Corp. (2-230)

"Prefinished" Plated Aluminum. American Nickeloid Co. (2-130)

Ingot Metal. Bohn Aluminum Co., Michigan Smelting & Refining Div. (2-204)

Magnesium. Fisher Furnace Co. (2-222)

Aluminum Alloy. Oscar W. Hedstrom Corp. (2-210)

LOW-MELTING METALS

Lead and Tin Products, Alpha Metal & Rolling Mills, Inc. (2-169)

Properties of Lead-Bearing Alloys. American Smelting & Refining Co., Federated Metals Div. (2-166)

Lead-Base Anti-Friction Alloy. Graphitized Alloys Corp. (2-183)

NOBLE METALS

Silver. Sherman & Co. (2-184)

SPECIAL METALS

Indium. Indium Corp. of America. Illustrations and graphs are included in this 10-page bulletin, which describes the uses and chemical and physical properties of indium. (2-242)

Molybdenum and Tungsten. American Electro Metal Corp. (2-128)

Resistance Alloys. Wilbur B. Driver Co. (2-167)

Rare Metals, Alloys and Ores. Foote Mineral Co. (2-19)

Metal Powders. Powder Metals & Alloys, Inc. (2-149)

3. Engineering Design

ALLOY CASTINGS

Stainless Steel Castings. Atlas Foundry Co., Atlas Stainless Steel Castings Div. (3-266)

Heat Resisting Alloy. Chicago Steel Foundry Co. (3-19)

Stainless Castings. Cooper Alloy Foundry Co. (3-9)

Nickel-Chromium Alloy Castings. Driver-Harris Co. (3-69)

Corrosion and Heat Resistant Castings. Michiana Products Corp. (3-91)

Alloy Castings. Sterling Alloys, Inc. (3-261)

CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

Centrifugal Steel Castings. American Cast Iron Pipe Co. This 20-page bulletin describes and profusely illustrates centrifugally cast steel products and includes complete data, in table form, on weight per ft. (lbs.) for various tube wall thicknesses. (3-374)

Heat and Corrosion Resistant Castings. American Manganese Steel Div., American Brake Shoe Co. (3-204)

Bronze Castings. Frontier Bronze Co. (3-195)

Corrosion-resistant Alloys. Lebanon Steel Foundry. (3-259)

Centrifugally Cast Non-Ferrous Metals. Shenango-Penn Mold Co. (3-339)

DIE CASTINGS

Designing Die Castings. New Jersey Zinc Co. A 14-page reprint presents complete data on factors to be considered when designing die castings. (3-373)

FORGINGS

Drop Forgings. Drop Forging Assn. (3-174)

Pressed and Forged Products. Lenape Hydraulic Pressing & Forging Co. (3-211)

METAL PARTS

Locking System. Bardwell & McAlister, Inc. The Rosán locking system for Rosán threaded inserts and studs is attractively described and illustrated in Bulletin No. 2, a 4-page folder. (3-370)

Metal Stampings. Bossert Co., Inc. Complete information on Bossert metal stampings is pictorially presented in an attractive, 15-page booklet. (3-371)

Steel Valves. Edward Valve & Mfg. Co., Inc. An 8-page folder is predominantly illustrated with a varied assortment of steel valves, both cast and forged. (3-372)

Electrical Contact Metals. Callite Tungsten Corp. (3-338)

Thermostat Metals. General Plate Div., Metals & Controls Corp. (3-181)

Magnet Manufacture. Indiana Steel Products Co. (3-359)

Beryllium Copper Springs. Instrument Specialties Co., Inc. (3-322)

Gilding Metal on Steel. Superior Steel Corp. (3-341)

Oil-less Bronze Bearings. R. W. Rhoades Metaline Co., Inc. (3-142)

Thermostat Metals and Electric Contacts. H. A. Wilson Co. (3-70)

NON-METALLICS

New Plastic. Dow Chemical Co. The story of Saran, the newest, versatile plastic, is revealed in this attractive 16-page bulletin. (3-369)

Metals and Alloys, 330 West 42nd St., New York, N. Y.

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Plastics. Continental Diamond Fibre Co. (3-357)

Plastics in Product Design. Durez Plastics & Chemicals, Inc. (3-93)

Plastic Data Book. Formica Insulation Co. (3-210)

Molded Plastics. General Electric Co. (3-283)

Rubber Substitute. B. F. Goodrich Co. (3-308)

Plastic Manufacturing Equipment. Haveg Corp. (3-170)

Plastic Tubing and Fittings. Elmer E. Mills Corp. (3-247)

Plastics. Monsanto Chemical Co., Plastics Div. (3-277)

Synthetic Rubber. Thiokol Corp. (3-367)

Corrosion-Resistant Equipment. U. S. Stoneware Co. (3-347)

Ceramic Plastics. Westinghouse Electric & Mfg. Co. (3-236)

POWDER METALLURGY

(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)

Sintered Iron Parts. Bound Brook Oil-Less Bearing Co. (3-252)

TUBING

Straight Seamless Tubing. Summerill Tubing Co. A single-page reprint briefly describes and illustrates the use of straightening equipment in seamless tubing. (3-368)

Special Tubing. Precitube Corp. (3-280)

In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

History of Piping. Tube Turns, Inc. (3-303)

OTHER METAL FORMS

Fabricated Metal Products. Falstrom Co. (3-198)

Steel Stampings. Worcester Pressed Steel Co. (3-273)

4. Melting · Refining · Casting

ALLOYING AGENTS

Exothermic Alloying Agent. Chromium Mining & Smelting Corp., Ltd. (4-47)

Alloys in Foundries. Niagara Falls Smelting & Refining Corp. (4-139)

AUXILIARIES

Metallic Filler for Castings. American Crucible Co. Useful data and directions for use are concisely presented in a pocket-size, 8-page bulletin. (4-176)

Casting Weight Calculator. National Engineering Co. This is a handy, cardboard slide rule by which the metal-weight of a casting can be speedily calculated from the dimensions of its parts. Instructions on how to use it are given on the back. (4-175)

Core Oil. Smith Oil & Refining Co., Industrial Oils Div. A 2-page brochure describes in full this company's No. 51 Polymer-type core oil for non-ferrous light metal castings, as well as their numerous other foundry products. (4-181)

Molding Sand Bonds. American Colloid Co. (4-161)

Magnetic Pulleys. Dings Magnetic Separator Co. (4-169)

Reclaiming Scrap Metal. Dreisbach Engineering Corp. (4-63)

Foundry Equipment. Modern Equipment Co. (4-146)

Mold and Core Wash. Refractory Mica Products, Inc. (4-107)

Foundry Core Oils. Swan-Finch Oil Corp. (4-157)

Universal Cut-Off Machine. Tabor Mfg. Co. (4-109)

Zirconite Products. Titanium Alloy Mfg. Co. (4-173)

REFINING AGENTS

Metal Purifiers. American-British Chemical Supplies, Inc. (4-156)
Aluminum De-gasers. Foundry Services, Inc. (4-162)

MELTING FURNACES AND PARTS

Pot Furnaces. Mahr Mfg. Co. A single sheet (equipment bulletin No. 280) gives concise data on both gas-fired tinning furnaces and combination tinning and babbitting pots, oil-fired. (4-174)

Low Frequency Induction Furnaces for Melting. Ajax Electric Furnace Corp. (4-78)
High Frequency Furnaces. Ajax Electrothermic Corp. (4-60)
Induction Furnaces for Aluminum Alloys. Ajax Engineering Corp. (4-95)
Electric Furnaces. American Bridge Co. (4-82)
Metal Melting Furnaces. Campbell-Hausfelt Co. (4-119)
Cutting Crucible Costs. Crucible Manufacturers' Assn. (4-36)
Crucible for Non-Ferrous Melting. Electro Refractories & Alloys Corp. (4-96)
Recuperative Open Hearth Furnaces. Fitch Recuperator Co. (4-101)
Electric Melting Furnaces. Pittsburgh Lectromelt Furnace Corp. (4-61)
Electric Melting Furnaces, Top Charging. Swindell-Dressler Corp. (4-71)

Duplex Melting. Whiting Corp. (4-160)

5. Heating · Heat Treatment

ATMOSPHERES AND GENERATORS

Heat-Treating Atmospheres. Westinghouse Electric & Mfg. Co. A new 16-page booklet, No. B-3251, describes four basic atmospheres which meet all requirements of annealing, brazing, hardening, tempering, gas carburizing, sintering and normalizing. (5-466)

SO_2 in Magnesium Industry. Ansul Chemical Co. (5-379)
Pure Carbon Monoxide. Girdler Corp., Gas Processes Div. (5-386)
Protective Atmosphere Furnaces. Hevi-Duty Electric Co. (5-449)
Drying Air or Gases. Pittsburgh Lectrodryer Corp. (5-65)

AUXILIARIES

Woven Wire Belts. Audubon Wire Cloth Corp. Bulletin F, 4 pages, describes and illustrates a variety of Metalwove belts for high temperature and air drawing furnaces. (5-479)

Oil Coolers and Heat Transfer Equipment. Bell & Gossett Co. Complete data on oil coolers, pumps, quench tanks, heat exchangers, etc. are presented in a 23-page, illustrated bulletin, No. OC-743. (5-476)

Quenching Dies. Meehanite Research Institute. A single-page reprint adequately describes Meehanite quenching dies to speed propeller production. (5-473)

Steel Hardening Solution. Steeltem Chemical Co. Steeltemp, a new steel hardening solution that simplifies the heat treating of tools and steels and improves the texture of the steel grain, is cited in a 3-page brochure. (5-477)

Dry-Ice Cabinet. American Instrument Co. (5-391)
Pressed Steel Pots. Eclipse Fuel Engineering Co. (5-352)
Cold-Temperature Processing. Kold-Hold Mfg. Co. (5-406)
Industrial Chilling Unit. Motor Products Corp., Deep-Freeze Div. (5-417)
Heat Exchanger for Metallurgical Operations. Niagara Blower Co. (5-293)
Sub-Zero Chest. Revco, Inc. (5-350)
Furnace Door Hoists. Fred J. Ryan Co. (5-333)
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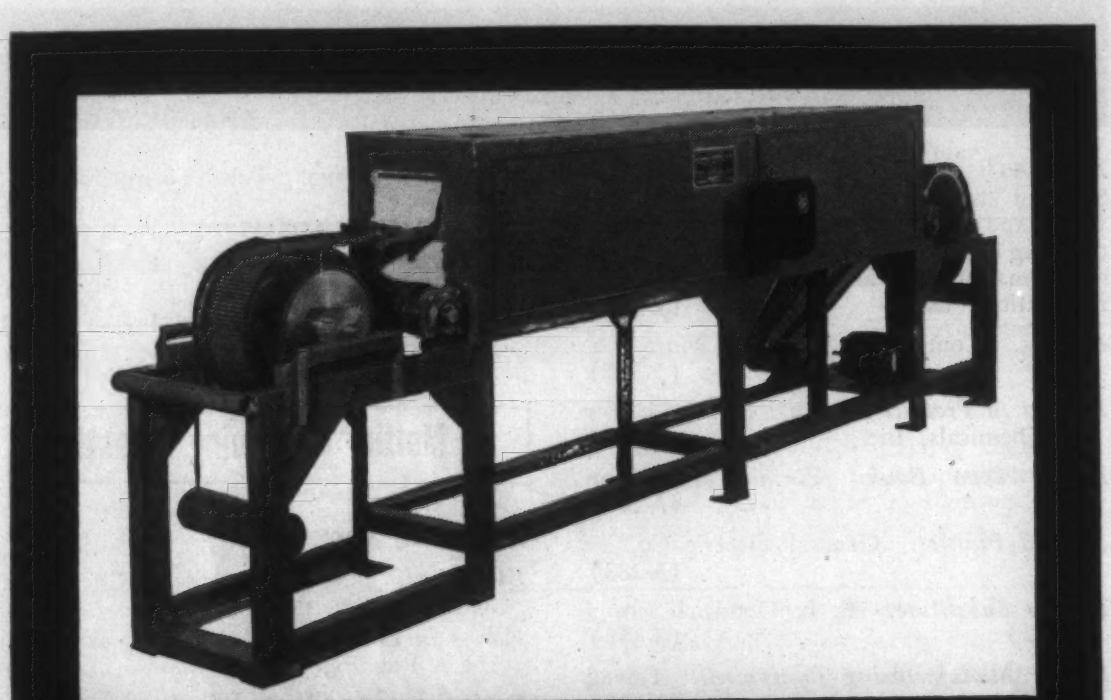
Wire Belt Conveyors for Furnaces. Wickwire Spencer Steel Co. (5-267)

BATHS AND COMPOUNDS

Case Hardening. American Cyanamid & Chemical Corp. (5-459)
Liquid Carburizing Baths. A. F. Holden Co. (5-446)
Carburization Check. Park Chemical Co. (5-351)
Cleaning Carburizing Compound. Thurner Engineering Co. (5-214)

BURNERS

Infra-Red Ray Burner. Carbomatic Corp. (5-398)



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Gas Appliances. Johnson Gas Appliance Co. (5-286)
Pre-Mixing Burners. C. M. Kemp Mfg. Co. (5-257)
Oil Burners. National Airoil Burner Co., Inc. (5-468)
Combined Gas and Oil Burners. Peabody Engineering Corp. (5-296)

ELECTRICAL HARDENING AND HEATING

High Frequency Induction Heating Equipment. Lepel High Frequency Laboratories, Inc. This 6-page folder lists numerous advantages obtained when using Lepel high frequency induction heating equipment. (5-480)

Electric Forging Heaters. American Car & Foundry Co. (5-23)
Electric Heat Treat Furnaces. C. I. Hayes, Inc. (5-456)
Induction Heating Data Sheets. Induction Heating Corp. (5-299)

FURNACES

Standard Heat Treating Furnaces. Surface Combustion Div., General Properties Co., Inc. Bulletin No. SC-102 presents a complete line of standard furnaces for heat treating operations. (5-474)

Industrial Furnaces. Wellman Engineering Co. Bulletin No. 111, 8 pages, pictorially presents a number of industrial furnaces for various heat treating purposes. (5-478)

Salt Bath Furnaces. Ajax Electric Co., Inc. (5-416)
Electric Pot Furnaces. American Electric Furnace Co. (5-97)
Furnace Periodical. Chicago Flexible Shaft Co. (5-291)
Industrial Furnaces. Dempsey Industrial Furnace Co. (5-453)
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Forced Convection Tempering Furnaces. Morrison Engineering Corp. (5-308)
Electric and Fuel Car-Type Furnaces. W. S. Rockwell Co. (5-298)
Gas-Fired Oven Furnaces. Rolnick Test- & Mfg. Co. (5-175)
Clean Hardening for High-Speed Tools. Sentry Co. (5-202)
Electric Heat Treating Furnaces. Harold E. Trent Co. (5-358)
Car Hearth Heat Treating Furnaces. Vulcan Corp. (5-255)

OVENS

Ovens for Finishing Processes. J. O. Ross Engineering Corp. (5-273)

PROCESSES

Surface Hardening. American Gas Furnace Co. A 4-page reprint presents complete data on the surface hardening of bearings and numerous other vital parts of mechanisms, and includes a description of typical ni-carbing cycles and equipment. (5-475)

Surface Hardening. Chapman Valve Mfg. Co. (5-149)
Surface Hardening Stainless Steel. Industrial Steels, Inc. (5-422)

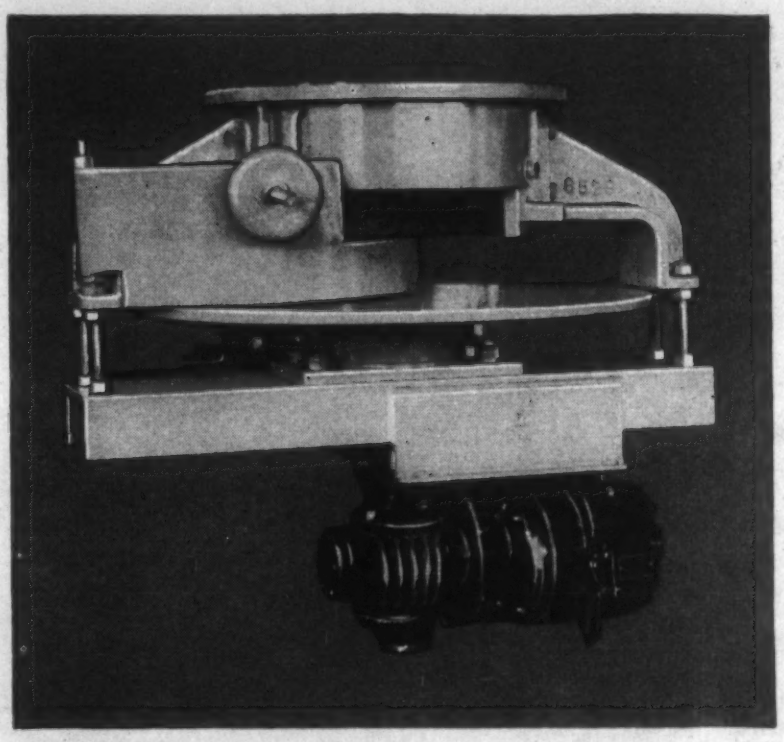
Please Use the Coupon on page 1433

6. Refractories · Insulation

Insulation. Eagle-Picher Lead Co. A 12-page pamphlet, entitled "Industrial Insulation" is packed with technical data on fill materials, flat materials, blocks, blanket, plastic, pipe insulation and protective coatings. (6-140)

Plastic Ramming Refractory. Ironton Fire Brick Co. Ironton Nojoint, a new plastic ramming refractory for lining receiving, mixing and desulphurizing ladles, is presented in an attractive bulletin. (6-141)

Furnace Refractories. Armor-Clad Co. (6-107)
Heat Transmission. Atlas Lumnite Cement Co. (6-136)
Refractories. Basic Refractories, Inc. (6-108)
Suspension Arches. Bigelow-Liptak Corp., Div. A. P. Green Firebrick Corp. (6-131)
Plastic Super-Cement. Botfield Refractories Co. (6-94)



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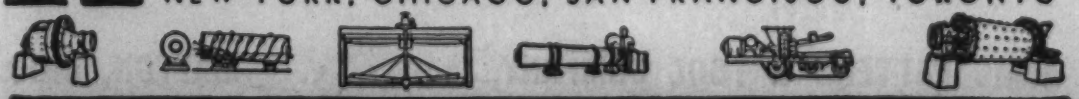

Refractory Coating Material. Brickseal Refractory Co. (6-67)
Heavy Duty Refractories. Carborundum Co., Refractory Div. (6-45)
Masonry Saw. Clipper Mfg. Co. (6-82)
Flux Resistant Refractory. Corhart Refractories Co. (6-95)
Refractories Maintenance Coating. A. P. Green Firebrick Co. (6-70)
Pocket Cost Calculator for Refractories and Insulation. Illinois Clay Products Co. (6-57)
Diatomite. Johns-Manville Corp. (6-134)
Refractory Mixture. Laclede-Christy Clay Products Co. (6-109)
Super-Refractories Products. Mullite Refractories Co. (6-75)
Firebrick. Plibrico Jointless Firebrick Co. (6-129)
Insulating Refractory Concrete. Quigley Co., Inc. (6-18)
Refractories and Insulations. Refractory & Insulation Corp. (6-135).
Refractories for Aluminum. Charles Taylor Sons Co. (6-133)
Silica Tubing and Rod. Thermal Syndicate, Ltd. (6-103)

7. Welding

BRAZING AND SOLDERING

Low-Temperature Welding. Eutectic Welding Alloys, Inc. (7-198)
Silver Brazing of Copper Pipe. Handy & Harman. (7-141)
Solders and Fluxes. Kester Solder Co. (7-116)
Silver Flux. Scaife Co. (7-224)
Soldering Fluxes. Wolfe-Kote Co. (7-239)

ELECTRIC ARC WELDING

Welding Stainless Steels. Allegheny Ludlum Steel Corp. A beautiful, 64-page bulletin presents complete data on the welding of stainless steels. Colored diagrams, charts and illustrations are an added attraction. (7-247)

A.C. Welder. Allis-Chalmers Mfg. Co. A new Ampac "400" a.c. welder is pictorially portrayed in a 4-page folder, Bulletin No. B-6302, with detailed specifications included. (7-250)

Electric Arc Welders. Mid-States Equipment Co. A 4-page folder describes several electric arc welders for heavy high-speed production welding, and presents their many advantages and specifications. (7-243)

Weld Rod Coatings. Philadelphia Quartz Co. A single sheet presents detailed information on fluxes and rod coatings. (7-248)

Stainless Steel Electrodes. Alloy Rods Co. (7-235)
Electrode Color Chart. Arcos Corp. (7-78)
Alternating Current Welding and Its Costs. General Electric Co. (7-122)
Austenitic Stainless Steel Electrodes. Harnischfeger Corp. (7-110)
Arc Welders. Hercules Powder Co. (7-206)
Changing Press Design for Welding. Lincoln Electric Co. (7-170)
Arc-welding Electrodes. McKay Co. (7-164)

GAS WELDING

Oxyacetylene Flame Adjustments. Air Reduction Co. (7-211)

RESISTANCE WELDING

Resistance Welder Control. General Electric Co. (7-150)
Resistance Welding Data Book. P. R. Mallory & Co. (7-87)
Spot and Seam Welders. Sciaky Bros. (7-163)

SUPPLIES

Hard-Facing. Coast Metals, Inc. The applications and advantages of Coast Metals hard-facing are presented in an attractive brochure. (7-245)

Fume Collectors. Ruemelin Mfg. Co. (7-228)

Welding and Brazing Fluxes. Superior Flux Co. (7-202)

8. Metal-Working

FORMING

Soap in Lubricants. American Soap & Glycerine Producers, Inc. A 4-page folder advocates soap in lubricants when making shell and cartridge cases, and as a reducer of friction in metal drawing. (8-356)

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Double-Flaring Tool. Imperial Brass Mfg. Co. Bulletin No. 337, a single sheet, describes and illustrates a double-flaring tool for thin wall steel tubing, and also presents brief sketches of a number of other service tools. (8-348)

Wire Straightening Machines. F. B. Shuster Co. A number of wire-straightening machines are fully described and illustrated in an 8-page bulletin, No. 42. (8-346)

Straightening and Bending Presses. Watson-Stillman Co. Bulletin No. 320-A, 37 pages, pictorially presents a complete line of hydraulic presses for straightening and bending operations of a variety of products covering every field of the metal industries. (8-358)

Die Matrix Alloys. Cerro de Pasco Copper Corp. (8-106)
Oil Hydraulics. Denison Engineering Co. (8-307)
Hydraulic Press. Hydraulic Press Mfg. Co. (8-140)
Metal Extrusion Press. Hydropress, Inc. (8-210)
Sheet Metal Facilities. Kirk & Blum Mfg. Co. (8-333)
Metal Spinning. Milwaukee Metal Spinning Co. (8-101)
Die-Casting Machines. Reed-Prentice Corp. (8-273)
Extrusion Presses, etc. John Robertson Co., Inc. (8-268)
Punch Presses. Wiedemann Machine Co. (8-332)

FORGING

Surface Peening. Pangborn Corp. Complete data on surface peening for inducing a residual stress in metals to increase fatigue strength are presented in an attractive, 12-page booklet. (8-354)

Swaging Machine. Standard Machinery Co. Typical applications of a hydro-former that saves metals by shaping and joining without cutting are presented in a single sheet. (8-343)

Drop Forgings. J. H. Williams & Co. Complete information on drop forgings—materials used, radial draft, stock for finish, etc.—is presented in a 2-page, cardboard folder. An interesting diagram and table are included. (8-355)

Helve, Etc. Hammers. C. C. Bradley Co. (8-305)
Hydraulic Presses. A. B. Farquhar Co., Ltd. (8-146)
Forging Furnaces. George J. Hagan Co. (8-230)

MACHINING

Metal Cutting Saw Blades. Capewell Mfg. Co. General information, diagrams and tables on metal cutting saw blades are presented in a compact, 20-page booklet. (8-349)

Oil Purifiers. DeLaval Separator Co. Complete data on the Uni-matic oil purifier and direct drive centrifugals for purifying factory oils are presented in a 4-page folder. (8-344)

Abrasive Cut-Off Machines. A. P. de Sanno & Son, Inc. A single sheet illustrates and briefly describes several Radiac abrasive cut-off machines, including wet-cutting only, dry cutting only and the combination wet and dry cutting types. (8-345)

Please Use the Coupon on page 1433

Tube Cutting Machine. De Walt Products Corp. An attractive, 3-page brochure presents illustrations, diagrams and specifications of a new tube-cutting machine designed for all types of straight and angular cut-off operations on tubes, bars, etc. in both ferrous and non-ferrous metals. (8-347)

Cutting Oils. Doall Co. The Doall 120 and 240 cutting oils for cooler and smoother cutting of non-ferrous and ferrous metals is described in a 4-page pamphlet. (8-353)

Cutting Fluids. D. A. Stuart Oil Co. This compact, 16-page bulletin offers complete data on how proper cutting fluids have solved production problems in war plants. (8-351)

Carbide-Tool Price List. Willey's Carbide Tool Co. Bulletin No. 143, 8 pages, presents a price list of all the metals, cutting tools, standard blanks, etc. produced by this company. (8-350)

Abrasive Cut-Off Machines. Catskill Metal Works, Inc. (8-315)
Adjustable Cutters. Robert H. Clark Co. (8-292)
Use of Broaches. Colonial Broach Co. (8-256)
Cutting Oils. Cities Service Oil Co. (8-19)
Cutting Oil Reclaiming Systems. Gale Oil Separator Co., Inc. (8-82)
Cutting Oil. Gulf Oil Corp. (8-141)

Ebonol "C"
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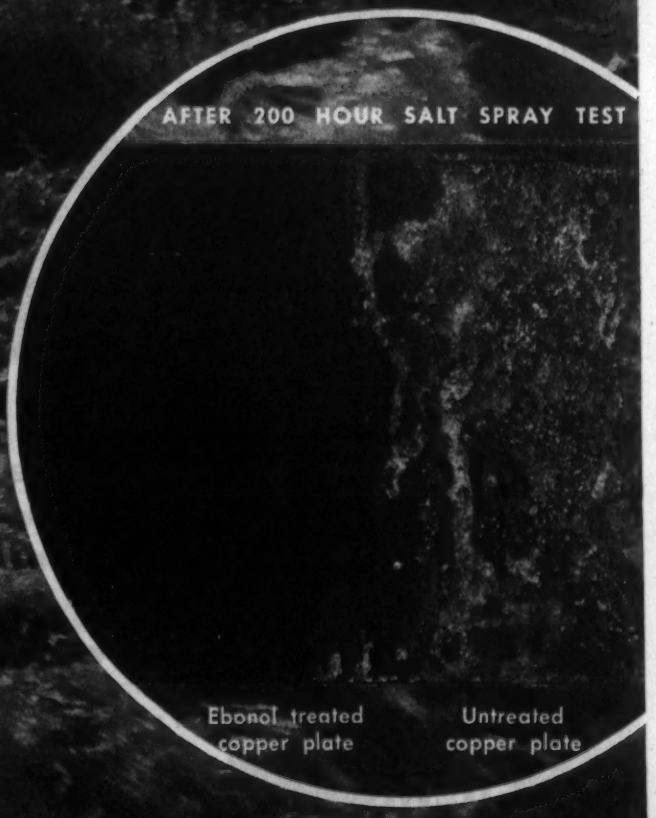
This is the black for copper and its alloys that lasts and protects. Ebonol "C" blackened copper withstands up to 20 hours in salt spray unoiled and up to 200 hours when oiled. It is adherent and ductile—easy to apply. Copper plated steel, when Ebonol "C" treated, affords much greater protection to the base steel especially when oiled.

Ebonol "C" is the ideal process for blackening copper, brass and bronze. It is widely used and war approved.



The above steel panel was copper plated 0.0002" thick. Half was Ebonol "C" treated and the whole panel was oiled. The unblackened section rusted at 16 hours and was badly rusted after 200 hours in salt spray. The Ebonol "C" treated half was almost perfect after 200 hours.

OTHER EBONOL BLACKENING PROCESSES
Ebonol "A" for Aluminum
Ebonol "S" for Steel and Iron
Ebonol "Z" for Zinc and Zinc Alloys

THE ENTHONE COMPANY
NEW HAVEN, CONNECTICUT
REPRESENTATIVES IN PRINCIPAL CITIES

Finishing Machines. Hammond Machinery Builders. (8-296)
Carbide Tools and Blanks for Cutting Steel. Kennametal, Inc. (8-157)
Bar and Tube Turning Machines. Medart Co. (8-318)
Gear Finishing. Michigan Tool Co. (8-271)
Machining of Stainless Steel. Rustless Iron & Steel Corp. (8-211)
Cutting Oil Filter. Sparkler Mfg. Co. (8-193)
Cutting and Grinding Facts. Sun Oil Co. (8-85)
Metal-Cutting Bandsaw. Universal Vise & Tool Co. (8-283)
Ball Joint Vises. Wall-Colmonoy Corp. (8-311)

ROLLING

Bending Rolls. Buffalo Forge Co. (8-74)

METAL POWDER PROCESSING

Presses for Powdered Metals. Kux Machine Co. (8-62)
Batch Mixers. Lancaster Iron Works, Inc. (8-129)
Metal-Powder Mixers. Patterson Foundry & Machine Co. (8-114)

RIVETING

Blind Riveting. Cherry Rivet Co. (8-328)
Explosive Rivets. E. I. duPont de Nemours & Co., Inc., Electrochemicals Dept. (8-357)

ANACONDA

Electrolytic ZINC

SPECIAL HIGH GRADE 99.99+% pure

The electrolytic refining process, originally conceived for the treatment of complex lead-zinc ores, consistently produces zinc of the highest purity. 47288

ANACONDA

ANACONDA SALES COMPANY

25 Broadway 4, New York

Subsidiary of Anaconda Copper Mining Co.

9. Cleaning • Finishing

CLEANING

Blast Cleaning and Dust Collecting Equipment. American Foundry Equipment Co. "The American Line," a reference catalog of the entire line of products manufactured by this company, is a revised edition, consisting of 20 pages. (9-346)

Deburring and Finishing Wheels. Carborundum Co. An attractive, 8-page folder illustrates the new "MX" wheels for removing burrs, tool marks, sharp edges, etc. after grinding. (9-360)

Emulsion Cleaning. Enthone Co. A 4-page folder describes emulsion cleaners designed for the rapid cleaning of all types of basis metals without attack. (9-350)

Degreasing Solvent. General Solvents Co., Inc. Penotrite No. 5, an azeotropic blend of solvents for vapor degreasing, is fully described in a 4-page folder. (9-359)

Metal Cleaning and Finishing Machines. Howard Engineering & Mfg. Co. Important new data and applications for metal cleaning and finishing machines are presented in an interesting, 32-page catalog. (9-349)

Metal-Finishing Equipment. Munning & Munning, Inc. An attractive brochure describes and illustrates Roto-Finish equipment, available in wet or dry processes, for de-burring, buffing, grinding, honing and polishing of metals, etc. (9-353)

Acid-Detergent Material. Oakite Products, Inc. A versatile, acid-type, water-soluble material designed to remove many types of deposits from ferrous and non-ferrous parts during fabrication—Oakite Compound No. 84—is described in a 12-page bulletin. (9-351)

Selenium Rectifiers. W. Green Electric Co., Inc. An attractive, 12-page bulletin describes and illustrates a number of selectro-platers, and briefly presents several other types of rectifier equipment engineered to meet special requirements. (9-347)

Metal Descaling. Bullard-Dunn Div., Bullard Co. (9-205)
Electro-Cleaning. Macdermid, Inc. (9-293)
Metal Cleaning. Magnus Chemical Co. (9-282)
Cleaning Compounds. Magnuson Products Corp. (9-254)
Metal Washing Machines. Metalwash Machinery Co., Inc. (9-306)
Heavy Duty Cleaning of Ferrous Metals. Pennsylvania Salt Mfg. Co. (9-129)
Dust Collecting Equipment. Peters-Dalton, Inc. (9-184)
Cleaning Equipment for Metals. N. Ransohoff, Inc. (9-230)
Processing Carriers. Rolock, Inc. (9-214)
Metal Cleaning. Solventol Chemical Products, Inc. (9-216)
Rust Prevention. The Texas Co. (9-332)
Cleaning Compounds. Turco Products, Inc. (9-153)

CHEMICAL TREATMENTS

Blackening Iron and Steel. Alrose Chemical Co. (9-95)
Finish for Steel. Heatbath Corp. (9-243)
Black Steel Finish. E. F. Houghton & Co. (9-255)
Chemicals for Protecting and Coloring Metal Surfaces. Mitchell-Bradford Chemical Co. (9-152)

Black Oxide Finish. Puritan Mfg. Co. (9-307)

ELECTROPLATING

Filter Equipment. Alsop Engineering Corp. (9-169)
Rectifiers. Hanson-Van Winkle-Munning Co. (9-226)
Chromium Plating. Industrial Chromium Corp. (9-322)
Industrial Filters. Industrial Filter & Pump Mfg. Co. (9-323)
Hard Chromium Plating. United Chromium, Inc. (9-159)

METALLIC COATING (NON-ELECTROLYTIC)

Lead Base Coatings. Carbozite Corp. (9-292)
Metallizing. Metallizing Engineering Co., Inc. (9-339)
Metal Spraying. Metallizing Company of America, Inc. (9-111)

NON-METALLIC AND ORGANIC COATINGS

Heat Resisting Paint. American Chemical Paint Co. Kemick, a chemical paint that insures rust protection to metal parts subjected to high temperature, is described in Technical Service Data Sheet No. 6-2-11-4, 4 pages. (9-354)

Heavy-Duty Paints. American-Marietta Co. This handy ordering catalog, fully illustrated, presents the Valdura line of heavy-duty industrial maintenance paints. (9-361)

Porcelain Enamel. American Rolling Mill Co. Useful data on porcelain enamel, and the type of iron best suited for porcelain enameling, are described and illustrated in an attractive, 24-page booklet. (9-352)

Spray Finishing Systems. Binks Mfg. Co. The complete line of industrial spray finishing systems is presented in an illustrated, 96-page catalog. A price list is included. (9-362)

Infra-Red Equipment. Fostoria Pressed Steel Corp. An attractive, 12-page bulletin describes and illustrates infra-red equipment to be used for both war- and peacetime production. (9-357)

Rust Preventive. Nox-Rust Corp. A new rust preventive for all ferrous and non-ferrous metals, Nox-Rust, is interestingly described and illustrated in an attractive, 18-page bulletin. An insert of the latest U. S. Government specifications (Aug. 1, 1943) is also included. (9-348)

Bonderizing. Parker Rust Proof Co. "The Parkerizer," a 4-page house organ, presents complete data regarding Bonderizing on steel. (9-356)

Protective Coating. Rheem Research Products, Inc. An attractive, 4-page folder describes and illustrates Iridite, a coating process that protects zinc or cadmium surfaces from corrosion. (9-355)

Corrosion Resistants. Corrosion Control Corp. (9-280)
Protective Coatings. Hilo Varnish Corp. (9-295)
Rust-inhibiting Wax Coatings. S. C. Johnson & Son, Inc. (9-234)
Protective Coatings. M. W. Kellogg Co. (9-253)

Please Use the Coupon on page 1433

Spray Finish Machines. Spray Engineering Co. (9-182)

PICKLING

Ferric Sulphate and Cartridge Cases. Monsanto Chemical Co., Merrimac Div. (9-176)

POLISHING

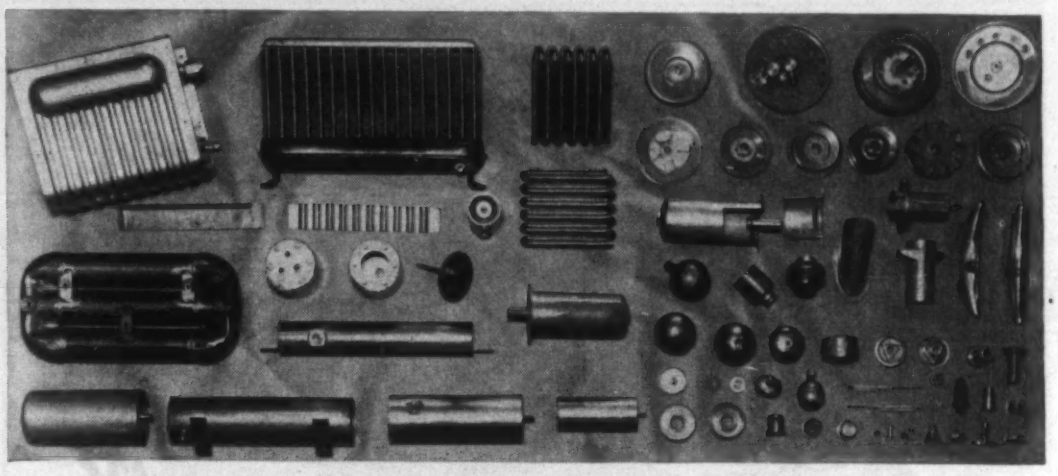
New Abrasive. Norton Co., Behr-Manning Div. A 13-page booklet describes a new product, boron carbide, and includes five tables, which present complete data on its resistivity, comparison, etc. (9-345)

Grinding Wheel Selector. Sterling Grinding Wheel Div., Cleveland Quarries Co. A handy, pocket-size specification selector, in loose-leaf form, offers the correct selection of proper wheels for each particular problem. (9-358)

10. Testing · Control

CONTROL INSTRUMENTS

Temperature Controls. Brown Instrument Co. "Control System for Hot Blast Temperatures—For Control of Both Mixing and Cold Blast Valves" is the title of a 5-page bulletin, No. BF-1, mostly text, but with one page of diagrams. (10-456)



Some parts and products joined by the electric furnace copper brazing process—assemblies ranging in size from small metal radio tube parts to large automotive and refrigerator units are joined neatly, securely and economically by this process.

Design Your Metal Parts For Copper Brazing

Miscellaneous steel assemblies are joined 60% to 75% faster at ¼ the former labor cost by the copper brazing process.

"Greatly improved results—neater, stronger joints—60 to 75% faster, at about one quarter the former labor cost," that briefly is the report received from the production manager of a prominent midwestern plant after installing an EF continuous copper brazing furnace for joining some of their steel assemblies.

Within a month after installing their first brazing furnace, a second similar but larger furnace was ordered for joining other products—both furnaces are now operating side by side, joining all kinds of assemblies—large and small—neatly, economically and securely.

Products difficult or expensive to make in one piece can be made in several pieces and joined—thus not only reducing the cost but actually improving the quality and appearance. Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly and economically joined right in the production line in your shop. Strong, leak-proof joints are made and the completed unit is discharged from the furnace—clean and bright.

Any number of joints in the same product or any number of pieces can be joined at one time. The most intricate parts or assemblies are made to actually "grow together," and joints made which are as strong, or even stronger than the original parts.

Investigate the brazing process for your products. With slight changes in design you may be able to join your metal assemblies, neater, cheaper and stronger by this method.

Send for printed matter showing various types of EF copper brazing furnaces.

Investigate the Copper Brazing Process For Joining YOUR Metal Parts

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

Heavy-Duty Weighing Scales. Detecto-Gram Scales Div., Detecto Scales, Inc. Specifications and illustrations of three new scales for heavy-duty weighing are presented in a single sheet. (10-464)

Temperature Control Equipment. Partlow Corp. Complete data on temperature controls, timers, recorders, thermometers, etc. are included in an illustrated brochure. (10-473)

Temperature Control. Tempil Corp. A colorful brochure briefly describes three industrial temperature measurement aids, and lists suggested recommendations for each. (10-467)

Standard Control Systems. Automatic Temperature Control Co. (10-256)

Flow Rate Meters. Fischer & Porter Co. (10-417)

Open-Hearth Furnace Control. Hays Corp. (10-425)

Pyrometer Control. Illinois Testing Laboratories, Inc. (10-42)

Temperature Controls. Leeds & Northrup Co. (10-347)

Immersion Pyrometer. Pyrometer Instrument Co. (10-8)

Pyrometers and the War Program. Wheelco Instruments Co. (10-249)

HARDNESS TESTING

Microhardness Testers. Eberbach & Son Co., Inc. (10-393)

Portable Brinell Hardness Tester. Andrew King. (10-148)

Hardness Testing Machines. Riehle Testing Machine Div., Am. Machine & Metals, Inc. (10-384)

Hardness Conversion Tables. Wilson Mechanical Instrument Co. (10-92)

INSPECTION DEVICES

Dial Indicator Hole Gages. Federal Products Corp. Complete instructions for setting and using the Model 1201 series of dial indicator hole gages are presented in an 8-page pamphlet. A table of specifications is also included. (10-461)

Precision Gages, Tools and Parts. Merz Engineering Co. In unique portfolio form, the four divisions of service of this company, *i.e.* engineering, standard gage, special tool and gage, and parts-manufacturing, are completely and interestingly described. (10-465)

Angle Computer. Angle Computer Co. (10-396)

Thermometers. Bristol Co. (10-419)

Surface Smoothness Tester. Brush Development Co. (10-192)

pH Meters. Gamma Instrument Co. (10-334)

Sheet Metal Dial Micrometers. Haines Gauge Co., Inc. (10-140)

Magnaflux. Magnaflux Corp. (10-288)

Glossmeters. Photovolt Corp. (10-427)

Illuminated Magnifiers. E. W. Pike & Co. (10-345)

Abrasive Wear Tests. Taber Instrument Co. (10-233)

Filtration of Coolants. U. S. Hoffman Machinery Corp., Filtration Div. (10-370)

MECHANICAL TESTING

Metallurgical Laboratory Equipment. Adolph I. Buehler. (10-199)

Dynamometers. W. C. Dillon & Co., Inc. (10-338)

Testing Equipment. Baldwin-Southwark Div. (10-121)

Electronic High-Magnification Recorder. Tinius Olsen Testing Machine Co. (10-344)

METALLOGRAPHIC EQUIPMENT

Data on Electron Microscope. R.C.A. Mfg. Co. (10-302)

Metallographic Polishing Powder. Conrad Wolff. (10-306)

RADIOGRAPHY

X-ray Apparatus. North American Philips Co., Inc. A striking, 4-page folder describes and illustrates the Norelco Searchray, an X-ray machine for the fluoroscopic inspection of cartons, packages, handbags, etc. (10-466)

Flexible Film Holders. Picker X-ray Corp. This flexible film holder, a versatile device that provides speed and efficiency in the radiography of curved or irregular objects, is interestingly illustrated in an attractive, 4-page folder. (10-469)

X-ray Film. Eastman Kodak Co. (10-170)

Industrial X-ray Units. General Electric X-Ray Corp. (10-324)

X-ray Diffraction Tubes. Machlett Laboratories. (10-300)

X-ray Equipment. Westinghouse Electric & Mfg. Co. (10-293)

SPECTROGRAPHY

Universal Spectrophotometers. Wilkens-Anderson Co. (10-180)

For the Extremes

and All Between

KENNAMETAL

HERE illustrated are two machining tools—one large, the other small, but each is a *great* tool—Kennametal. The cutting edge for the large one is ground on a tip of carbide brazed to the steel shank, that for the small one is ground on a solid round piece of carbide. Each is just as keen as the other for its specific purpose, each equally distinguished for superior performance on jobs within its scope of application. The large tool is for rough turning, the small tool for precision boring.

Here are two extremes in size and purpose, but in between is an array of Kennametal tools suitable for a wide variety of uses—thirty or more different styles, many sizes in each, five available grades of carbide in varying degrees of hardness. Every Kennametal tool, when fitted to its specific job, and correctly used, makes a distinctive contribution to the metal working industry. Maximum machining production, superior finish, accuracy to close tolerances, enduring service—these are outstanding characteristics.

Our new Catalog 43C gives information for selecting, ordering, and maintaining the wide variety of Kennametal tools. Do you have a copy? If so, are you making full use of it?

KENNAMETAL Inc.

Trade Mark Reg. U. S. Pat. Off. 158 LLOYD AVE., LATROBE, PA.

KENNAMETAL THE All American CARBIDE

LABORATORY AIDS

Frequency Meters. James G. Biddle Co. Vibrating reed meters from 10 to 500 cycles per sec. are described in an 8-page pamphlet, containing photos, text and price lists. (10-457)

Laboratory Utilities. Precision Scientific Co. Bulletin No. 600, 112 pages, contains detailed information on an extensive variety of laboratory apparatus and equipment and a number of practical ideas for improving laboratory efficiency. (10-462)

High-Speed Electrolytic Analysis. E. H. Sargent & Co. (10-219)

11. Equipment and Machinery, General

Heavy Equipment. Alamo Iron Works. Mill and gin, special pumping and concrete bar fabricating machinery are a few of the many types listed in a 4-page folder, which gives history and over-all facts of the company. (11-155)

Metal Baskets. Buffalo Wire Works Co., Inc. A general picture of a number of wire baskets for heavy duty or light loads, large or small objects, their accessories and attachments, materials of construction, and methods of joining and assembling, is presented in a 4-page, highly-illustrated folder. (11-172)

Coolant Cooler. Frostrode Product. Bulletin No. 75-AC, 2 pages, describes and illustrates a new coolant cooler for accurate temperature control of coolants and lubricants in machine processing. (11-174)

Tube Mills. Hardinge Co., Inc. Bulletin No. 18-A, an exceedingly attractive 16-page booklet, presents complete information on a number of tube mills, and includes several tables on ball- and pebble-tube mill data. (11-175)

Overhead Conveyors. Lamson Corp. A 4-page folder pictorially presents complete data on overhead conveyors, and cites a specific installation. (11-171)

Industrial Mixers. Mixing Equipment Co., Inc. "Lightnin" and "Mixco" mixers for producing process adapted agitation are described and illustrated in a 4-page folder. (11-180)

Paper Label Paste. Paisley Products, Inc. A 4-page folder describes a paste that fastens paper labels to parts made of most any material, including metal. (11-166)

Hydraulic Cable Stretchers. Parker Appliance Co. Illustrations and text in a 4-page folder aptly describe the Parker hydraulic cable stretcher for testing and stretching all types of aircraft cable assemblies. (11-173)

Hydraulic Elevators. Revolvator Co. Elevators for many industries are described in a 4-page illustrated booklet. Included is a device for feeding large metal sheets to a press easily, the workman's foot controlling the elevating button. (11-135)

Coolers. Ross Heater & Mfg. Co., Inc. Types "Cp" and "CF" coolers for lubricating, cutting, quenching and transformer oils, hydraulic presses, vapor condensers, etc. are described and illustrated in an attractive, 24-page bulletin, No. 5322. Numerous charts and tables are included. (11-181)

Magnesium Fire Extinguishers. St. Regis Paper Co. This 4-page folder is illustrated by still and action pictures, showing fierce fires brought under control by a portable machine for magnesium-working plants. (11-163)

Industrial and Ventilation Filters. Staynew Filter Corp. A very attractive, 40-page bulletin presents in two separate sections complete data on both industrial and ventilation filters. (11-179)

Oil Purifiers. Youngstown Miller Co. A 6-page folder, illustrated, presents the company's lines of lubricating and hydraulic oil reclaimers. (11-165)

Colloidal Graphite. Acheson Colloids Corp. (11-114)

Pulverized Coal. Amsler-Morton Co., Inc. (11-162)

Protecting Plastic. Ault & Wiborg Corp. (11-115)

High-Temperature Glass. Corning Glass Works. (11-154)

Chemicals for the Metalworker. Glyco Products Co., Inc. (11-137)

Preparing Engineering Reports. Alexander Hamilton Institute. (11-113)

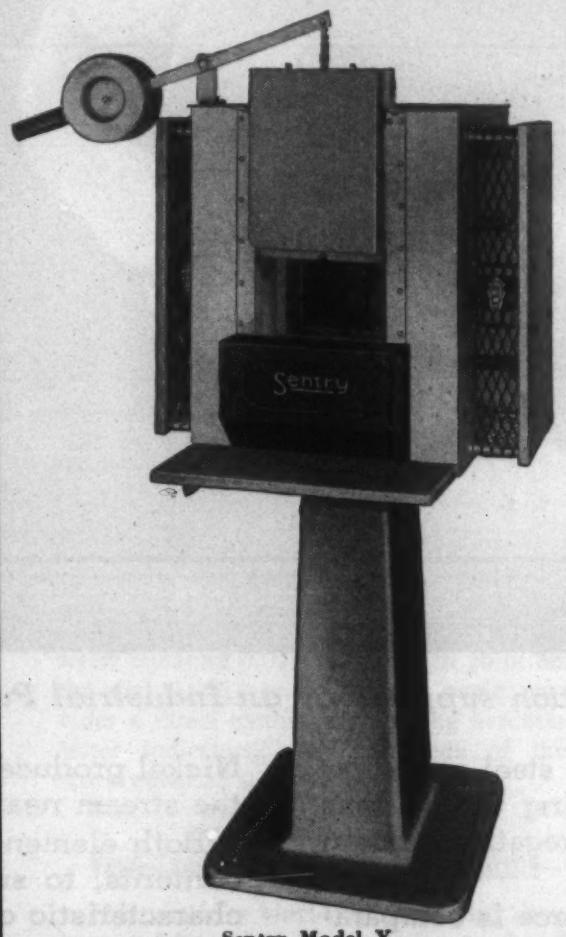
Acid Proof Cement. Pennsylvania Salt Mfg. Co. (11-71)

Centrifugal Blowers. Roots-Connersville Blower Corp. (11-102)

Vacuum Cleaning in Industry. Spencer Turbine Co. (11-28)

Please Use the Coupon on page 1433

BE PREPARED!



Sentry Model Y
High Speed Steel Hardening
Furnace

For Production Change Over Now or Later

Equip now with facilities to harden your High Speed Steel Tools easily —and when you want them.

A **Sentry Model Y Furnace** and **Sentry Diamond Blocks**

will provide you with hardened High Speed Steel Tools that are

— CLEAN
— HARD
— FREE FROM DECARB

***Any Alloy* — MOLY, TUNGSTEN, COBALT**

Simplicity and economy go hand in hand . . .
Special Training* and *Expensive Equipment
are *not needed.*

Write for Bulletin 1024-1B

Sentry "Always on Duty"

The Sentry Company
FOXBORO, MASS., U.S.A.

Information supplied by an Industrial Publication

The loss of recoverable alloys in steel scrap has been a major problem confronting the various conservation agencies. Proper segregation of scrap is one effective answer.

Segregation of scrap at the source is comparatively simple. The difficulty comes in preventing mix-ups in subsequent handlings. They can be prevented or remedied by applying two simple tests—spark and spot.

The presence of molybdenum, or nickel, or both, is readily detected by spark testing. Molybdenum causes an easily recognized secondary burst at the end of the spark stream resembling a spearpoint. Nickel produces a spot of intensely white light in the stream near the grinding wheel.

Both elements have a tendency, in the higher contents, to suppress the supplemental bursts characteristic of carbon steels.

Several spot tests for molybdenum have been developed. The simpler ones depend on the red color produced by either potassium ethyl xanthogenate or sodium thiocyanate added to a molybdate obtained from the etched surface of the steel. The dimethyl glyoxime test for nickel also depends on a red coloration. Many of these tests are approximately quantitative.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue · New York City

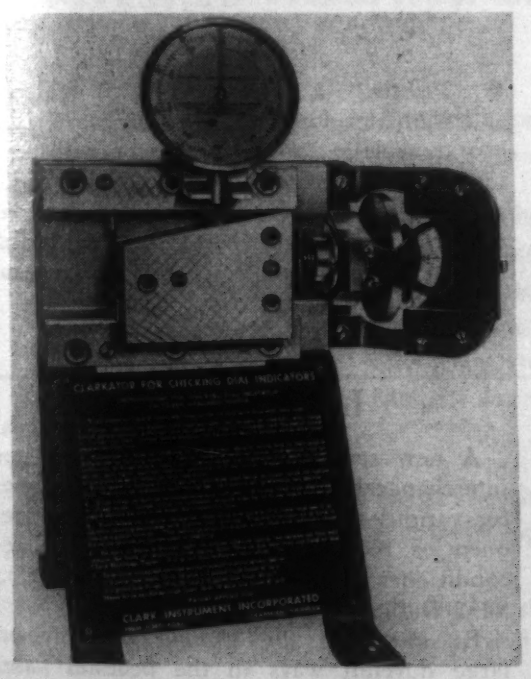
MOLY

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Checking Dial Indicators

A new device for checking the accuracy of dial indicators, such as those on Rockwell hardness testers, is announced by the *Clark Instrument Co.*, 10200 Ford Road, Dearborn, Mich. Called the "Clarkator," it employs the sine bar principle, checking



against the tangent of the angle. The indicator to be tested is mounted on the top of the Clarkator with its spindle resting on a lapped angle block, which is advanced or retracted by a screw.

When the zero reading coincides with the dial face on the Clarkator, the screw is revolved in either direction to check other indicator readings. A mirror facilitates reading of the Clarkator dial.

The front angle is used when checking standard indicators, each revolution of the screw equaling 0.020 in. and each point on the dial 0.0002 in. The back angle provides a direct method of checking hardness tester indicators, each revolution of the screw equaling 0.01962 in.

Vinyl-Type Plastic, Rubber Substitute

"Marvinol," a vinyl-type plastic, has demonstrated its superiority to both natural and synthetic rubber for such varied applications as automobile inner tubes, elastic gloves and many industrial and home uses, states Glenn L. Martin, president of the *Glenn L. Martin Co.*, Baltimore. It is not a synthetic rubber but a completely new material, better for many purposes than natural rubber. Thus, an inner tube holds air indefinitely.

It is 100 per cent reclaimable, and the basic ingredients are coal, air, salt and water. Manufacturing processes are far less complicated than those used to produce Buna and other synthetic rubbers. It is reclaimable due to its thermoplastic nature, superior as to abrasion resistance, flexes without fatigue, and is impermeable to gases and liquids.

"Marvinol" contains a sealed-in, non extractable plasticizer that causes properties whereby air, water, sunlight, acid and alkaline solutions and temperatures up to 250 deg. F. have no effect. Thus, the compound retains elasticity, resiliency and flexibility just as pure gum rubber, but does not have rubber's tendency to oxidize or age.

Inner tubes have traveled on cars 6000 miles in official tests without the addition of a single pound of air.

Spectrographic Steel Standards

The *National Bureau of Standards* is prepared to furnish a number of steels in rod form suitable for spectrographic standards. The 18 standards now available were selected for checking important representative points of composition among several types of carbon and low-alloy steels.

The values of concentrations are sufficiently well distributed in most cases to provide analytical curves for manganese, silicon, copper, nickel, chromium, vanadium and molybdenum.

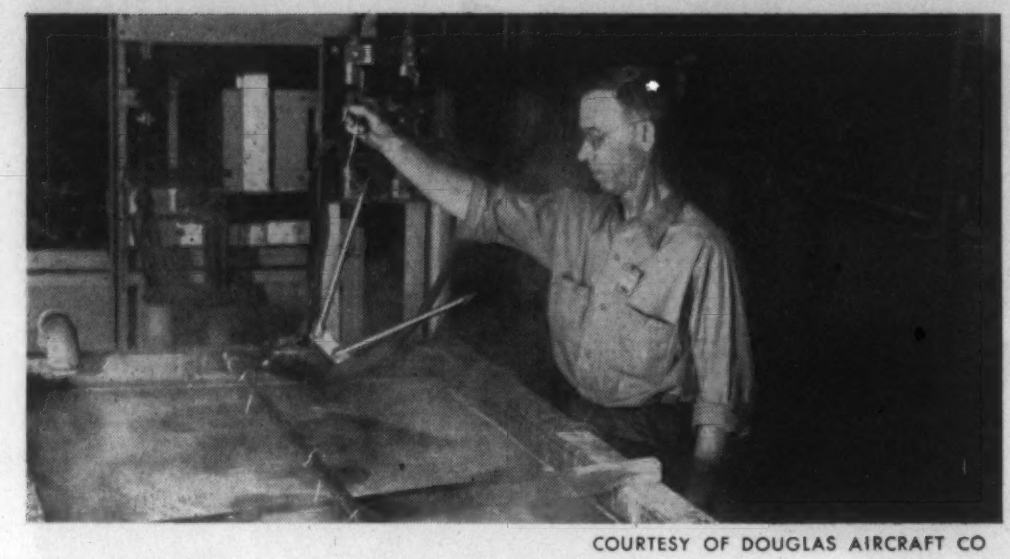
The standards are issued in two sizes: (1) Cylindrical rod 7/32 in. diameter, 4 in. long (approximately 22 g); and (2) cylindrical rod ½ in. diameter, 2 in. long (approximately 50 g). The standards are numbered in consecutive order in two series, the first beginning with 401 for the 7/32 in. rods, and the second beginning with 801 for the ½ in. rods.

The standards may be ordered by number from the National Bureau of Standards, Washington, D. C., at a price per sample, in either series, of $3.00, irrespective of the number of samples ordered.

The identifications and compositions of the standards are given in the provisional certificate.

FLAWLESS ELECTROPLATING

Insured by New Double-Function Cleaner



COURTESY OF DOUGLAS AIRCRAFT CO

PROSOLV B Cleans physically and chemically

How clean is "Clean"?

Not clean enough in today's wartime zinc electroplating unless it includes *both physical and chemical cleanliness.*

Zinc plating, like cadmium or copper, will not adhere over traces of rust or scale. So – when work is cleaned for zinc plating—oxides, mill scale and corrosion products must be removed – as well as grease and dirt.

That's why TURCO'S new PROSOLV B cleaner is filling an essential need in American industry.

PROSOLV B goes to work in the cleaning tank like a fine precision tool. Its accurate, powerful action penetrates and removes grease and carbon smut, rust and scale. The resulting metal surfaces are physically and chemically immaculate . . . ready for a perfect plating job.

Try this specially formulated product that is solving plating problems in many warplants throughout the country. It is adaptable for practically any plant requirement because it can be used in any standard steel tank equipment.

SEND FOR DESCRIPTIVE LITERATURE TODAY

BUY WAR BONDS

Turco

PRODUCTS INC.

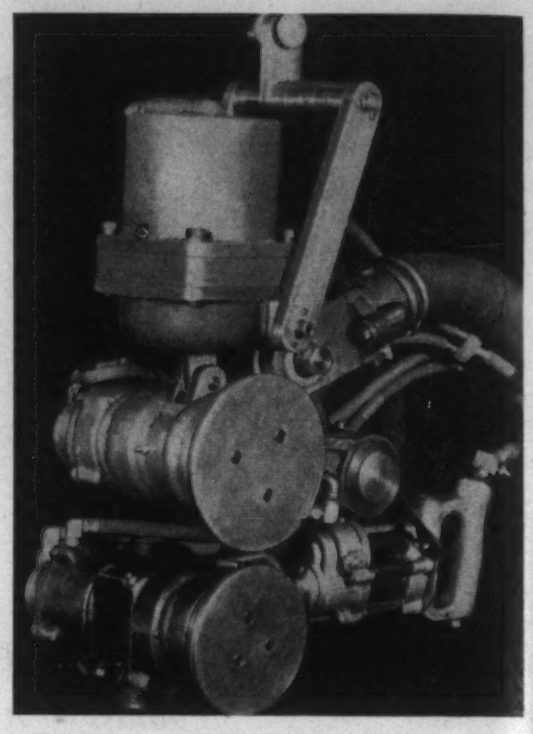
SPECIALIZED INDUSTRIAL CHEMICAL COMPOUNDS

MAIN OFFICE & FACTORY: 6135 SO. CENTRAL AVE., LOS ANGELES 1
SOUTHERN FACTORY: 1606 HENDERSON ST., HOUSTON 10, TEXAS
CHICAGO OFFICE & FACTORY: 125 WEST 46TH ST., CHICAGO 9, ILL.
SERVICE MEN AND WAREHOUSE STOCKS IN ALL PRINCIPAL CITIES

28-123

Portable Seam Welding Gun

Where the work is too big to take to the machine, a portable air-operated seam welder has been designed by *Progressive Welder Co.*, 3050 E. Outer Drive, Detroit 12. It is already in use welding 22 ft. long seams



on disposable light-weight gas tanks. It welds steel up to 2 in. thicknesses of No. 20 gage, including stainless steels.

The gun is universally suspended, and can be swiveled to weld in any direction, horizontal or vertical. The head is operated by an air motor using 42 cu. ft. of air per min. under load. With a 2 h.p. motor, its standard speed is 48 to 52 in. per min., using standard rolls or wheels.

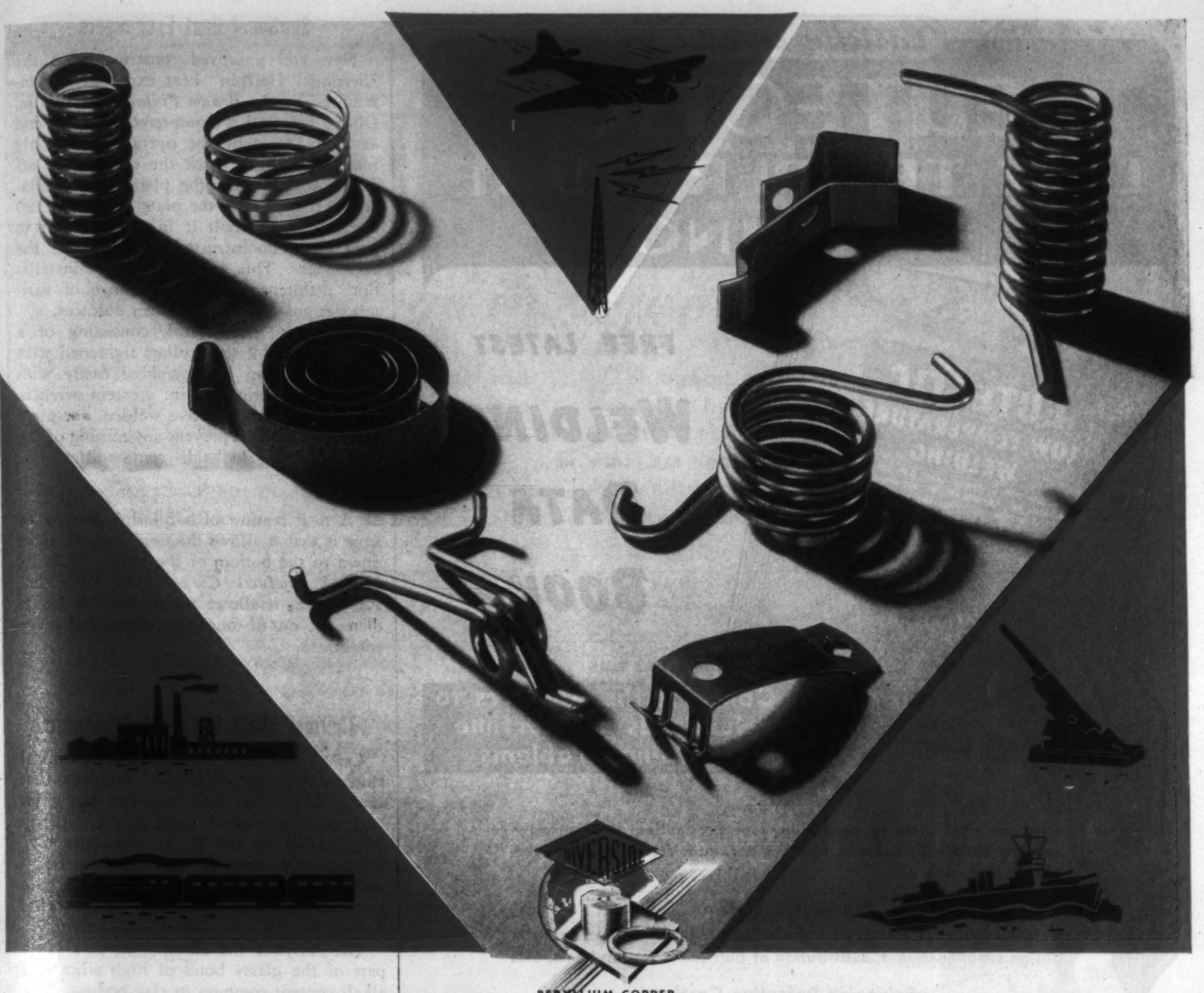
Air passing into the handle runs the motor. A push on the control button operates a solenoid switch, letting air into the cylinder on the gun, with a maximum pressure of 1400 lbs. per sq. in., with 90 lbs. of line pressure, sufficient for stainless steel.

● "Prestite," a mixture of clay, feldspar and flint, developed by *Westinghouse,* is a new porcelain, tough enough to withstand high altitude flying, now protects the radio systems of bombers and fighters and is used for insulators in battleships and tanks. It protects against moisture, violent temperature changes and electrical flashovers.

Tap Reconditioners

A new spindle head that accommodates interchangeably a wide range of motor types for various service voltages, phases and frequencies required features a new tap reconditioner of the *Detroit Tap & Tool Co.*, 8432 Butler St., Detroit 11.

By mounting the spindle assembly on large dovetail ways in the pedestal base, high rigidity of the spindle head plus continuous adjustability for grinding tool wear is obtained. The tap chamfering unit, at the left of the machine, is of the precision collet type, accommodating collets from the smallest machine screw size to 1¼ in. standard tap shank size, including long shank taper taps.



RIVERSIDE PHOSPHOR BRONZE *and* BERYLLIUM COPPER ALLOY

for Vital Springs

Riverside Phosphor Bronze and Beryllium Copper Alloy springs are used for a great many applications in the equipment of our armed forces.

Phosphor Bronze, one of the oldest spring materials is still one of the best. It is widely used in the war effort because it combines high strength and corrosion and wear resistance with great toughness, fatigue and corrosion-fatigue resistance. It also has good electrical conductivity. Where stability is important, a low temperature relief annealing treatment has been developed for Phosphor Bronze springs which results in good resistance to drift.

Beryllium Copper Alloy has an unusual combination of properties. When properly heat treated, it is the strongest copper base alloy. Designing engineers are taking advantage of its high strength and precipitation hardening qualities in the production of aircraft instrument springs where space and light weight are of vital importance. A great advantage to the fabricator is that springs may be formed from rolled sheet or drawn wire of moderate temper and then heat treated to develop the extraordinary high strength and spring properties. The alloy is much stronger and stiffer than Phosphor Bronze, yet it offers equally good corrosion and wear resistance. It has a greater resistance to fatigue and a higher electrical conductivity. Correctly heat treated Beryllium Copper Alloy springs are more stable and resistant to drift than any other spring material; hence the wide use of this alloy for instrument and other calibrated springs in vital applications. The advantages of Beryllium Copper Alloy springs have been definitely proved both for war and peace time applications.

Riverside Phosphor Bronze and Beryllium Copper Alloy are the products of an organization which specializes in their manufacture. If you are faced with a problem involving the selection of the right spring material, the cooperation of our technical staff is yours for the asking.

THE RIVERSIDE METAL COMPANY

Producers of these Vital Alloys:

BERYLLIUM COPPER • PHOSPHOR BRONZE • NICKEL SILVER
Sheet Strip Wire Rod

RIVERSIDE ... Burlington County ... NEW JERSEY
NEW YORK HARTFORD CLEVELAND CHICAGO

Castolin Eutectic*

EUTECTIC*

(Means Lowest Binding Alloy)

LOW TEMPERATURE WELDING

FREE LATEST

WELDING DATA BOOK

Contains the Answers to Hundreds of Wartime Welding Problems

Contains vital facts to speed up your production and cut your welding costs with Eutectic Low Temperature Welding. Also valuable information on:

Production Welding

Joining dissimilar metals and dissimilar gauges without burning • Design simplification • Substitution of butt joints for lap joints, etc.

Salvaging Defective Castings

Effectively at low cost • Completely machinable, invisible welds • Ideal for thin walled or heavy castings in all metals.

Maintenance Welding and Tool Salvaging

"Hard-to-get" tools costing up to $180 and requiring up to 50 weeks for delivery, salvaged for re-use in a few minutes at a cost of but a few cents.

Ordnance Plant Engineer writes: "Book very instructive, send ten more for distribution."

Write for Welding Data Book D. *Reg. U. S. Pat. Off.

EUTECTIC WELDING ALLOYS COMPANY

Originators of the Low Temperature Welding Process

40 WORTH STREET, NEW YORK, 13, N.Y.

See our Exhibit
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Chemical Industries
BOOTH No. 403
Madison Square Garden
N. Y. Dec. 6-11

EUTECTIC WELDING ALLOYS COMPANY
40 Worth St., N. Y. 13, N. Y.
Please send your latest Welding Data Book D
Name_____
Company_____
Address_____ City_____

Sectional Heat Exchangers

New and improved construction of the "Sectional Hairpin" heat exchanger is announced by the *Brown Fintube Co.*, Elyria, Ohio. Featured is a non-removable rear end assembly, whereby the operator need only remove the bolts, back the cover plate off far enough to clear the plates of the adjacent section, swing the plate through a 180 deg. arc, and rebolt it in this position to gain clear, unobstructed entrance into the exchanger. This greatly simplifies installation, maintenance and interchange of various designs of heat exchanger surfaces.

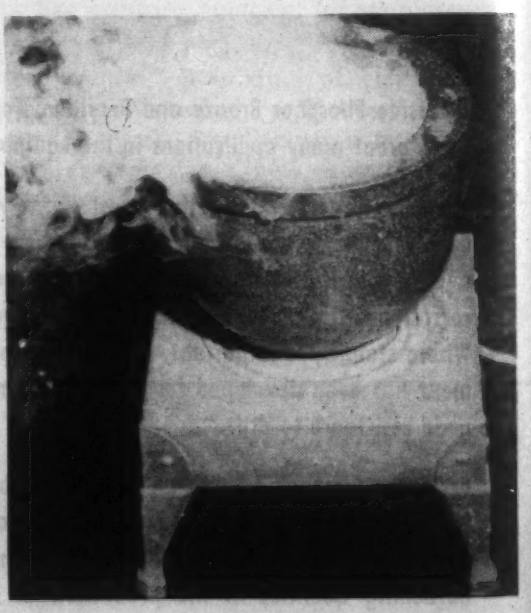
The new "head" seal, consisting of a solid ring and 2 split collars tightened with cap screws, can be assembled easily with only a conventional 8-in. crescent wrench. The new exchangers have welded, one-piece "hairpins," which prevent any mixing of the tube-side and shell-side commodities.

● A new feature of a blind hole type of gage is that it allows the user to check right down to the bottom of the hole. Made by *Federal Products Corp.*, 1144 Eddy St., Providence, it allows one to explore inside diameter, out-of-roundness, taper and other conditions.

Thermal Shock-Resistant Stoneware

Called the first low-porosity chemical stoneware in the history of ceramics that can be heated by direct steam or hot gases and can be cooled quickly, "Ceratherm 500," made by the *U. S. Stoneware Co.*, Akron, Ohio, actually increases in strength when heated to 400 deg. F. and quenched, and shows no loss of strength after repeated heating to this temperature and cooling.

The secret is the elimination of a large part of the glassy bond of high silica and alkali content common to clay bodies. The new chemical stoneware has a body of exceptional strength, low porosity and high thermal conductivity—a body 27 per cent stronger and a thermal conductivity 4 times normal.



"Ceratherm 500" is now in large-scale production on such items as tanks, crocks, boiling kettles, mixing kettles, cooling and condensing coils, evaporating dishes, pumps, pipe, etc. Materials are all non-critical.

ANNOUNCING

a change in organization

Our friends in the metallurgical field will be interested in the announcement of a change in the activities of the Adolph I. Buehler organization.

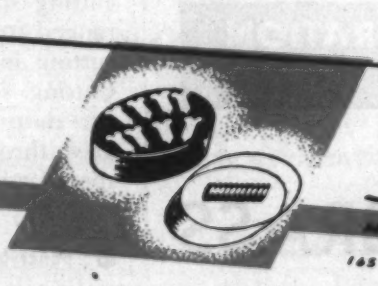
This change is made in order to enable us to maintain a close personal contact with our customers and at the same time provide expanded facilities for handling the rapidly increasing demand for metallurgical testing equipment.

A new organization, Buehler, Ltd., a partnership under my personal direction, will hereafter handle all metallurgical apparatus and sample preparation equipment.

The optical equipment will continue to be handled by the Adolph I. Buehler organization supervised by Mr. George Graves who has long been associated with my staff and who will devote all his efforts to serve you in this field.

The policy of both companies will continue, as in the past, to present equipment of the highest standard of quality in both optical and metallurgical apparatus. Some new and important developments that are anticipated in the field of metallurgical testing apparatus make this change in organization of particular significance to the metallurgist.

Adolph I. Buehler



Buehler Ltd.

A PARTNERSHIP

METALLURGICAL APPARATUS

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TELEPHONE CENTRAL 8912

PARTNERS
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Cut-Off Machines — Polishing Abrasives —
Polishing Cloths — Hand Grinders —
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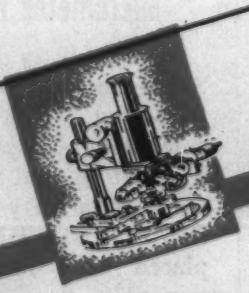
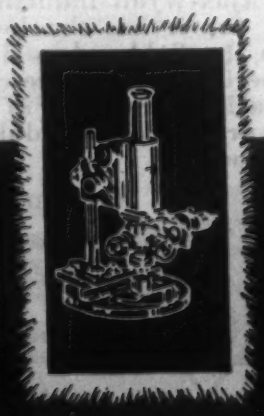


Adolph I. Buehler

OPTICAL INSTRUMENTS

228 N. LA SALLE STREET, CHICAGO 1, ILLINOIS • TELEPHONE CENTRAL 6827

Metallographs — Microscopes — Magnifiers — Macro Cameras —
Titrators — Stereoscopes — Dilatometers — Refractometers —
Spectrographs — Carbon Meters — Colorimeters — Pyrometers —
Hardness Testers — Dust Counters

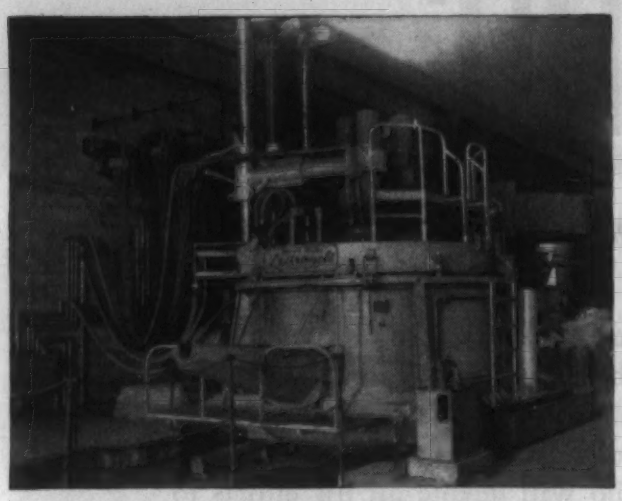


Adolph I. Buehler

OPTICAL INSTRUMENTS ★ METALLURGICAL APPARATUS

228 North LaSalle Street, Chicago 1, Illinois

MOORE RAPID *Lectromelt* FURNACES



TOP CHARGE TYPE

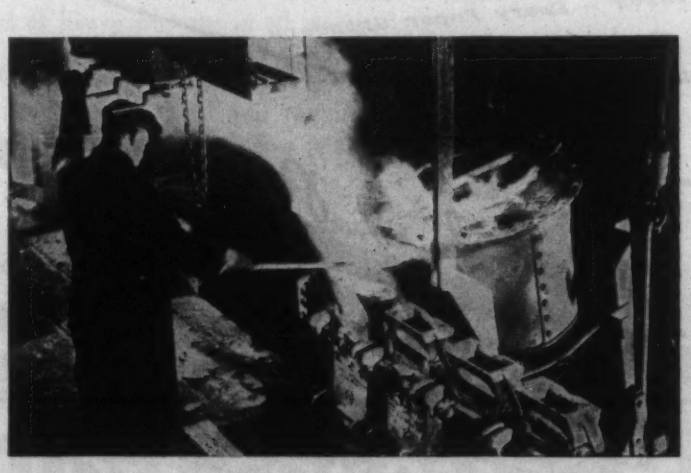
Illustrated is a recent installation of a 10 ton capacity, top charge type, Lectromelt furnace in normal operating position. This is the second Lectromelt installed in the same plant, and a third is now being built. These and many others are now producing essential alloy steel 24 hours per day, 7 days a week.

Use of top charge type LECTROMELTS results in greater production, lower power consumption, lower electrode and refractory costs, and increased tonnage per man-hour. They are built in standard sizes ranging from 100 tons down to 250 lbs. Write for information on LECTROMELTS to meet your melting requirements.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:



Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS" — the magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia, Pa.

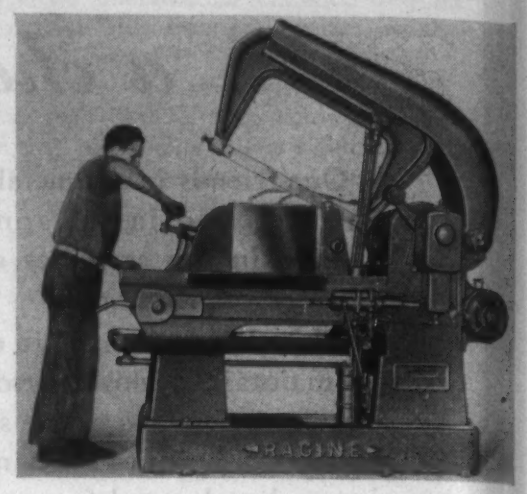
*HUNDREDS OF MILLIONS OF POUNDS ANNUALLY

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

Heavy Duty Metal Cutting Machine

Designed to provide low cost cutting with a thin cutting tool in large size materials, the *Racine Tool & Machine Co.*, Racine, Wis., has brought out a new 20 in. x 20 in. capacity metal cutting machine, Model 36 C. It is particularly adaptable to use on die block steel and other costly materials.



The light blade removes only a small amount of metal as chips, a substantial saving resulting from this feature alone.

The machine is operated hydraulically, full control being placed on a single lever. A special dual type feed provides a fast cutting speed in light materials, yet is arranged for a positive predetermined rate of cutting in die blocks, alloys and tool steel. Cutting speeds of 55-85 and 115 strokes per min. are provided. A 3 h.p. motor drive through V-belts is connected to the 3-speed transmission by a twin disc clutch.

● Plastikon putty, used chiefly now for sealing metal joints in combat equipment, and for other glazing and sealing purposes, is now made of synthetic rubber and is superior to natural crude rubber, the previous product, according to *B. F. Goodrich*, Akron, Ohio.

Micrometer for Boring Bar Cutters

A micrometer devised at *General Electric's* Schenectady Works for gaging the setting of boring bar cutters saves time and eliminates the guesswork involved in bringing the cutting tool to proper position by the usual cut-and-try method. It is a modification of a standard type with the anvil replaced by a block in which a recess is ground to accommodate the boring bar.

A ¼-in hole is drilled through the recessed portion of the block in line with the spindle to permit insertion of a wrench for easy adjustment of the tool in the boring bar. To use the gage, it is necessary to take one cut and thereby determine just how much more stock has to be removed from the bored hole to bring it to proper size. The distance the tool protrudes from the bar can be determined readily with the gage.

Then, by backing off the spindle of the gage a distance equal to the amount of stock to come off each side of the bored hole, the tool point can be brought up to the gage spindle and locked in position.

Park #200 Quench Oil

A faster oil for all Quenching Operations

Another step forward in the metal industry is this No. 200 Quench Oil recently developed in the Park Research Laboratories. It is an "accelerated" quench oil that greatly enhances the hardening of steel and is not affected by carry-over from salt baths.

This Park No. 200 Quench Oil is being used by some of the largest manufacturers in the country, and has been proved most successful in their heat treating departments.

Comparison of the hardenability curves obtained in Park No. 200 Oil with those obtained in ordinary quenching oils shows a greater surface and center hardness.

It is true that there is but a few seconds difference in cooling rates between this No. 200 Quench Oil and others but these few seconds make all the difference between partial and complete hardening or the difference between costly rejects or inspection proof work.

For complete technical data about this Park No. 200 Quench Oil or Park's No. 100 and "S" Quench Oils, phone one of our representatives listed below or write us today. No obligation, of course.

SPECIALISTS IN HEAT TREATING SINCE 1911

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atc HIGH SPEED MOTORIZED VALVES

Use any standard temperature, pressure, flow or level measuring instrument equipped with "High" and "Low" contacts.

For remote manual opening and closing of valves, use a two-contact push button station.

★For inaccessible locations

★Easily installed in vertical or horizontal pipe lines

★Complete Line

3 SIZES | 5 SPEEDS 2,3,4,5,7 sec. | LIFT FORCE to 550 lb.

★Select special features for your application . . .

- *Weather-proof*
- *Explosion-proof*
- *Acid-proof*
- *Water-jacketed*
- *Minimum Flow*

★General Specifications

Universal, reversible motor drives a power screw thru a sturdy gear reduction. Limit switch built-in. Operates slip-stem valves for any medium, up to 12" size and normally used pressures.

NEW DATA

Send Catalog A3

Name

Title

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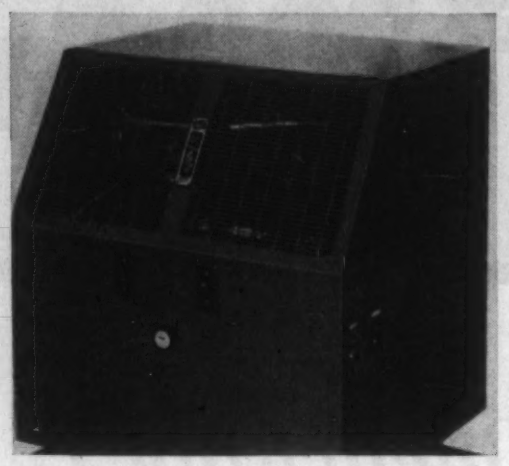
Address

atc Industrial Controls

AUTOMATIC TEMPERATURE CONTROL COMPANY, INC.
34 E. LOGAN STREET, PHILA. 44, PA.

Industrial Fluid Cooler

An all-purpose industrial fluid cooler that cools fluids, applies them and automatically settles out chips and abrasives, is now being marketed by the *Gray-Mills Co.*, 219 W. Ontario St., Chicago. Model 400 is especially suitable for metal cutting, hydraulic



oil applications, maintenance of submerged bearing temperatures, quenching oils, spot welders and laboratory set-ups.

It is 44 in. high, with other dimensions 28½ and 33 in., and is completely portable. It is equipped with a 1-h.p. compressor rated at 11,800 B.t.u.'s. Centrifugal or gear type coolant pumps operated by a ½-h.p. motor are optional. The centrifugal has a rated capacity of 3000 g.p.h. (water at no head) at 7 lbs. pressure, the gear pump being rated at 180 g.p.h. at 50 lbs. pressure.

The 35-gal. cooling tank has removable 45° settling and filtering screens and baffle-plate for removing chips and coarser abrasives.

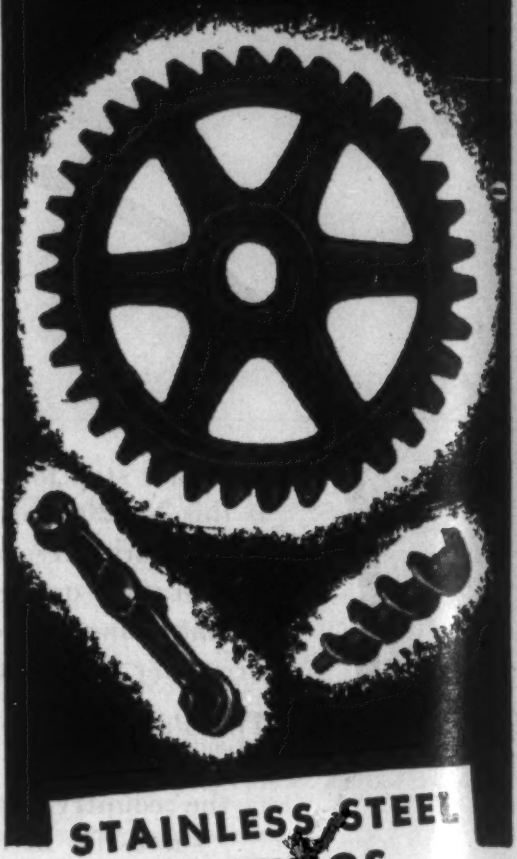
● Fluxes, known as A.B.C. Foundrates, manufactured by the *American-British Chemical Supplies, Inc.*, 180 Madison Ave., New York, find about 90 per cent of their applications and orders in the non-ferrous field and 10 per cent in iron and steel.

New Chemical for Copper Electrotyping

A new chemical allows a pound of copper to cover one-third more square inches of the surface of electrotype printing plates, assures a smooth finish and speeds plating. With this "B.C.F. addition agent," put out by the *Electroplating Div., E. I. du-Pont de Nemours & Co., Inc.*, less than 1 oz. is needed per gallon of copper electroplating solution. It reduces by one-third the copper required, and cuts in half the resulting scrap.

The chemical so increases the hardness of the copper deposit that only a much thinner layer is needed. It eliminates inferior plating on the edges and corners of the printing plates. Electrotypers formerly used 2200 tons of copper anodes annually. These printing plates are made by electrodepositing a thin layer of copper on a specially prepared mold of wax. When the mold is removed, the copper shell is backed up with tin and an alloy, then mounted on a wooden block for locking into the page forms.

Scientifically Controlled Alloy Analyses



STAINLESS STEEL CASTINGS

Unusual skill is required for the production of corrosion resistant castings of correct analyses to combat the attack of salt, caustic, acids, heat and abrasion. Many Atlas foundrymen have been specializing in alloy steel castings for over twenty years and are able to determine the proper analyses for any desired specification. Our engineering facilities are available to minimize your problems. Much can be gained by consulting with us when your product is in the layout stage for it is then that our assistance can be of full value.

Bulletin available on request.

ATLAS

STAINLESS STEEL CASTINGS

Division Atlas Foundry Co.

520 LYONS AVENUE IRVINGTON, N. J.

The portable extinguisher 80 feet long!

No, not the container... that's a handy unit only 7 inches in diameter by 27½ inches high. But the carbon dioxide it contains, stored under high pressure, expands 450 times in volume when it's released. That's enough of the fire-smothering gas to fill a cylinder 80 feet long by 2 feet in diameter! And that's why this Kidde product is one of the fastest fire-fighters known.

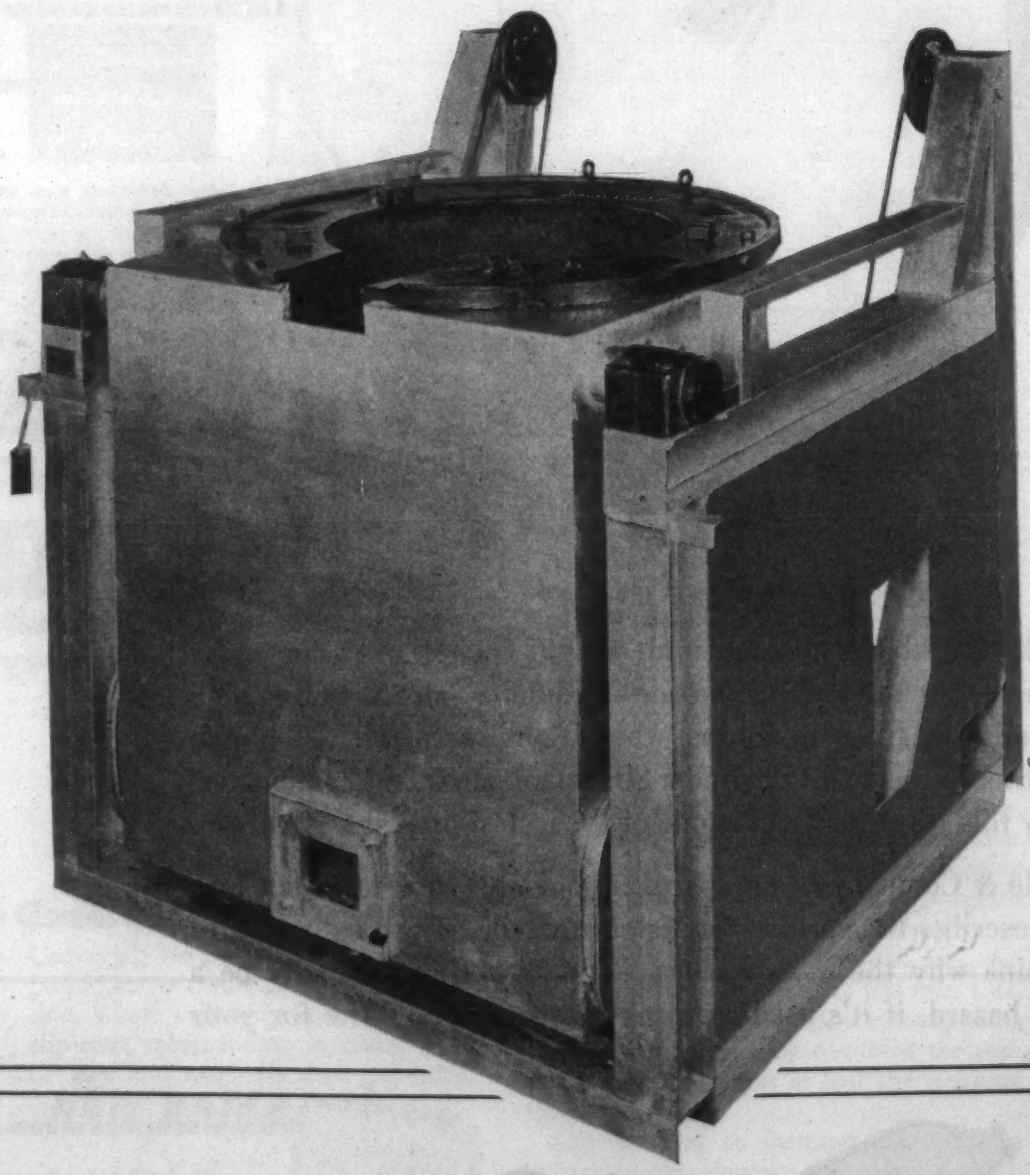
Walter Kidde & Company has prepared a booklet, "How to Teach Fire Fighting." It describes the various classes of fire, tells how to fight each of them. It explains why the most modern extinguisher can actually be a dangerous fire hazard, if it's used against the wrong fire! Write for your copy—it's free.

WALTER KIDDE & COMPANY, INC., 1231 MAIN STREET, BELLEVILLE, N. J.

MONARCH FURNACES

for Magnesium *and* Aluminum

- *MOTORIZED NOSE POUR*
- *HAND TILTING*
- *STATIONARY*



THE MONARCH ENGINEERING AND MANUFACTURING CO.

Curtis Bay Baltimore, Md.

Gear Testers

For detecting and locating faults during the process of manufacturing precision gears, as well as for checking the accuracy of gears when completed, the Comparitol gear tester has been brought out by the *George Scherr Co.*, 128 Lafayette St., New York.

The center distance may be checked quickly by setting up the instrument to the proper distance with gage blocks or standards. The master, or correct, gear is placed on an arbor and the doubtful gear is placed on another arbor directly in contact with the master. The master gear bracket is provided with a counter-balance, which can be adjusted so that the pressure between the two gears is always uniform.

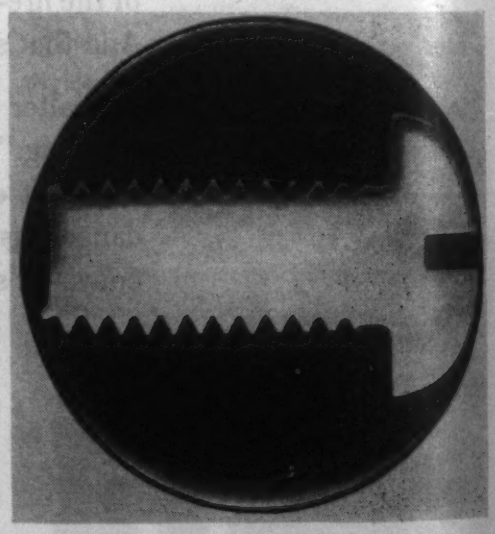
Beneath the doubtful gear appears a handle with piniion for rotating the gears. Any divergence is shown in the comparator head, which reads to 0.001 in., 0.0005 in., 0.0025 in., or 0.0001 in., as desired. This tester will definitely expose rolling action between two working gears, or gear and pinion. It discloses any eccentricity and discerns any variation in tooth thickness. It will also check gear train assembly, giving any indication of run-out.

● A new "pebble" finish for machine tool surfaces not only uses far less finishing materials, but can be applied in one-third to one-half less time. It dresses up a machine surface without fillers, sanding and sealing paint. By this method a machine can be finished in three operations instead of seven. It was developed by *Sherwin-Williams Co.*, 295 Madison Ave., New York.

Paint Protection from Carburization

"No-Kase" is a stop-off paint for selective carburization on steel parts in liquid carburizing baths, providing positive protection from carburization on such difficult sections as threaded edges. It is made by the *Park Chemical Co.*, Detroit.

It is easily confined to the area where protection is desired, and within an hour is



sufficiently dry for immersion in the carburizing bath. The heat burns out the vehicle of "No-Kase" paint and leaves the pigment as a continuous metallic coating.

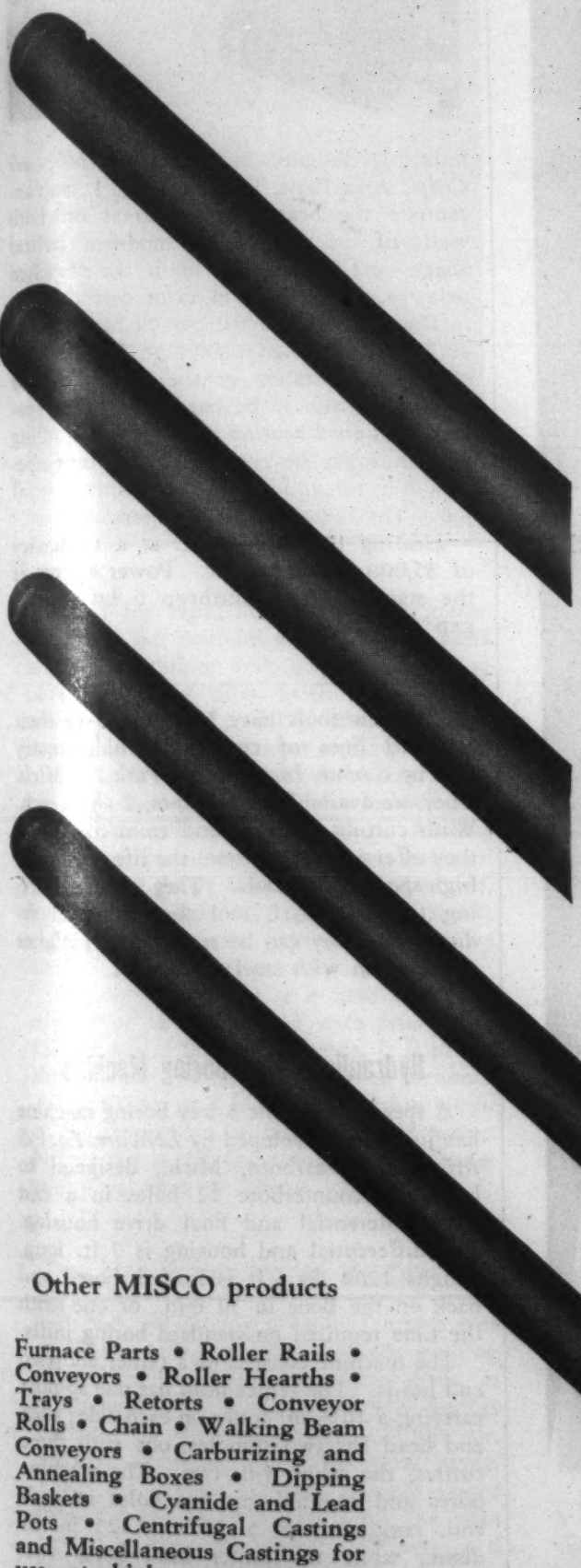
Any coating remaining after carburizing and quenching is easily removed by wire brushing.

MISCO *Rolled*

THERMOCOUPLE

Protection Tubes

For use in furnaces and liquid heating mediums



MISCO rolled thermocouple protection tubes give more than customary protection to thermocouples. Walls are thin, accurate, absolutely uniform, giving quicker response to temperature variations. At the same time they are sounder, denser, more durable than heavier tubes of cast construction. They never fail to outlast cast tubes under identical conditions and offer best protection against heat and corrosion.

Made in several analyses to suit requirements, Misco rolled thermocouple protection tubes assure satisfactory results in operating temperatures up to 2200°F. Available in all diameters and lengths with threaded or plain ends. We will be glad to quote upon request.

Other MISCO products

Furnace Parts • Roller Rails • Conveyors • Roller Hearths • Trays • Retorts • Conveyor Rolls • Chain • Walking Beam Conveyors • Carburizing and Annealing Boxes • Dipping Baskets • Cyanide and Lead Pots • Centrifugal Castings and Miscellaneous Castings for use at high temperature or under corrosive conditions.

★ BUY U. S. WAR BONDS ★

MICHIGAN STEEL CASTING COMPANY *1999 Guoin Street* **DETROIT 7, MICHIGAN**

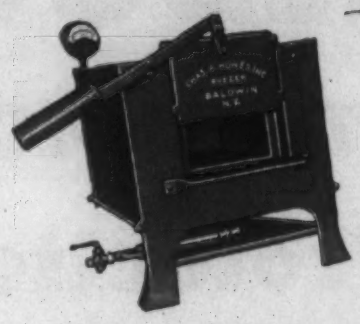
MISCO
Heat and Corrosion Resistant Alloys

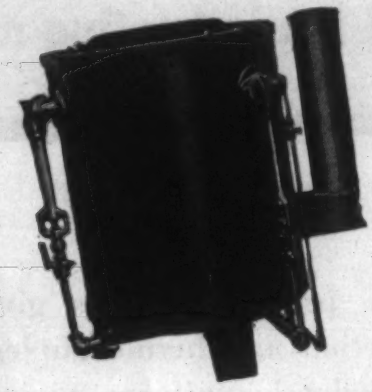
One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castings

"BUZZER" HIGH SPEED *Gas* FURNACES

SEMI MUFFLE OVEN FURNACES→

2000°F. obtained quickly without Blower, Power or auxiliary equipment. Just connect to your gas supply. Available in bench and floor models.





←ATMOSPHERIC POT HARDENING FURNACES

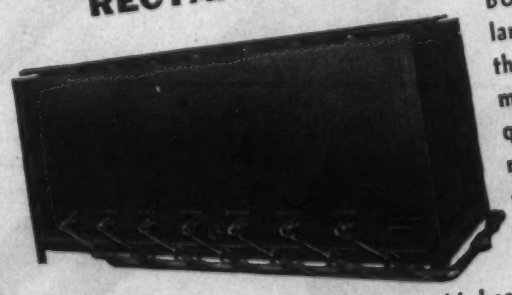
Atmospheric Pot Furnaces, tangentially fired, assure even heat up to 1650°F., quickly. These furnaces are ideal for Salt, Cyanide, Lead Hardening and Melting Aluminum and Zinc.

No Blower or Power Necessary — just connect to Gas Supply

FULL MUFFLE FURNACES→

Full Muffle Furnaces attain temperatures of 2400°F., without Blower or Power and are used for treating high carbon and alloy steels. Also available in Bench models.

RECTANGULAR HEAT BATH3



BUZZER Rectangular Heat Baths meet the increased demands for large liquid Heat Bath Furnaces. Built in many sizes, these furnaces attain high temperatures without blower or power and are suitable for liquid heat treating, soft metal melting, etc.

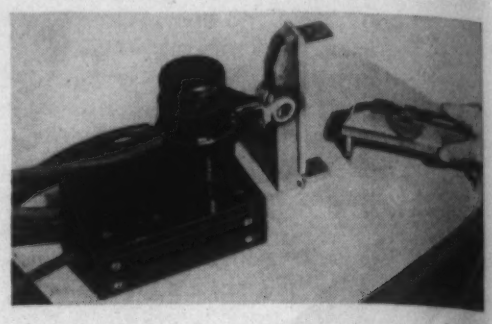
• for more details and complete catalog, write to

CHARLES A. HONES, INC.

127 So. Grand Ave. Baldwin, L.I., N.Y.

Special Induction Heating Coil

Quick localized heat-treatment of a certain ordnance part, depicted in the accompanying photograph, is made possible by a unique induction heating coil. The focus



inductor, designed by *Ajax Electrothermic Corp.*, Ajax Park, Trenton 5, N. J., to concentrate the heat in small areas on both walls of the part, is of modified helical shape, and is designed to fit the standard primary of the focus inductor assembly.

The two walls of the part fit between the coils. The area of maximum heat is concentrated accurately at the center of the coil at the site to be hardened. The specially-designed heating inductor and holding jig can easily be replaced by another special inductor and jig for any other special job. The inductor coil is watercooled.

Heating time is 35 sec. at a frequency of 35,000 cycles per sec. Power source is the standard Ajax-Northrup 6 kw. spark-gap converter.

● Six new tools have been added to their standard lines of cemented-carbide rotary files by *Carbur, Inc.*, Lincoln Park 25, Mich. They are available in 3 shapes, 2 sizes each. With cutting teeth ground from the solid, they offer at least 50 times the life of similar high-speed steel tools. They reduce burring time per part, tool sharpening is reduced and they can be run at much higher speeds than with steel rotary files.

Hydraulic 3-Way Boring Machine

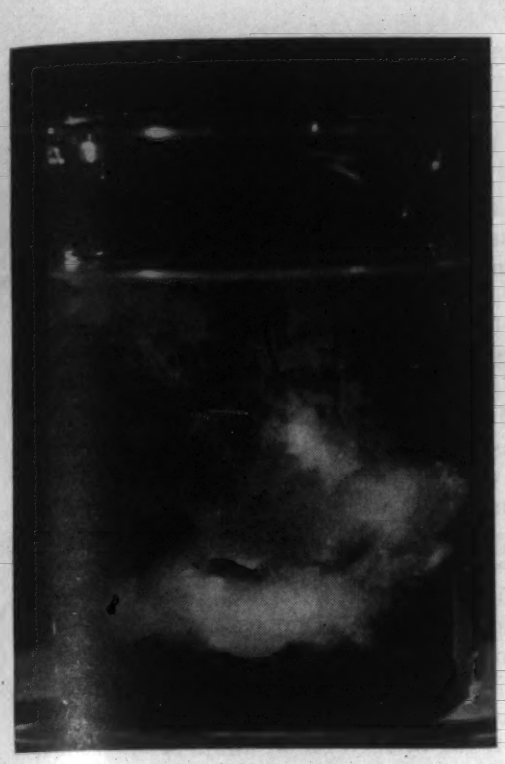
A special hydraulic 3-way boring machine has just been developed by *LeMaire Tool & Mfg. Co.*, Dearborn, Mich., designed to bore and counterbore 12 holes in a cast steel differential and final drive housing. The differential and housing is 7 ft. long, weighs 1200 lbs. It is loaded, bored and back on the floor in 30 min., or one-tenth the time required on standard boring mills.

The machine consists of a center and two end heads. The center head has one spindle carrying a 10½-in. cutter on each side; each end head has two spindles, one with three cutters, the other with two. The machine bores and counterbores five holes in each end, ranging from 5.118 to 7.125 in. in diam., while the center head bores two main bearings, 10.501 in. in diam., also sweeping the shoulder bearing seat. All holes are held within 0.0012 in. tolerance.

Both end heads feed while the center head bores one large bearing. When one large bearing is bored, the center head reverses and rapidly advances to a feeding position to bore the large bearing on the opposite side.

Two New Emulsion Cleaners

Two new emulsion cleaners are announced by the *Enthone Co.*, New Haven, Conn., one the "cleaner" and the other the "cleaner concentrate." The first is an emulsifiable solvent in the ready-to-use condition,



designed for rapid cleaning of oil, grease and solid dirt without attack on any basis metal. It enables fast, complete cleaning of very oily or dirty work, giving more adherent, brighter and less porous electrodeposits and more adherent organic finishes.

The work is swished in the cleaner, then rinsed in running cold water, which emulsifies the cleaner with all the dirt. A short immersion in an alkaline cleaner follows. The cleaner is of high penetrating power, has high emulsifiability and rinses rapidly and completely. Its flash point is above 100° F. and has no bad odor.

The second cleaner is a base of strong emulsifiers that is mixed with from 9 to 15 volumes of solvent naphthas. It is profitable for users of large amounts of cleaners.

The photograph is of an emulsion cleaner on immersion of work in cold water. Notice the rapid dispersion of the cleaner with an absence of jelling.

Trail-Blazing Arc for Welding

A high voltage "trail blazer," which cuts an electric path through air, speeds welding of delicate aluminum and alloy steels in warplane construction. It literally knocks electrons off the atoms of gas in the air, thereby conducting electricity more easily. Then, the regular welding current jumps from the rod to the metal along the path created by the trail blazer. Welding is 6 to 12 times as fast as gas welding.

Developed at the *Sharon Transformer Div., Westinghouse,* this "arc stabilizer" is an assembly of coils, condensers and transformers built into an electric welding machine. Part of the stabilizer is a spark gap oscillator, used in radio transmitters in the crystal set era. It produced electricity that had a high voltage, changing its direction of flow many thousands of times a second.

Previously, low currents had to be used to prevent burning of the thin metals, making it difficult to start the electric arc and keep it glowing while welding. Gas welding is slower because the flame has a lower temperature and the heat cannot be so concentrated.

Clamp Devices for Large Assemblies

The "Airop" for activating toggle clamps and to hold down large parts or assemblies where clamps would be required to encircle a job, such as airplane wings, has been developed by *Airop, Inc.*, Dearborn, Mich. With it the operator need not repeatedly walk around the work to manipulate the many clamps. A gang of Airops can be controlled from one central control valve.

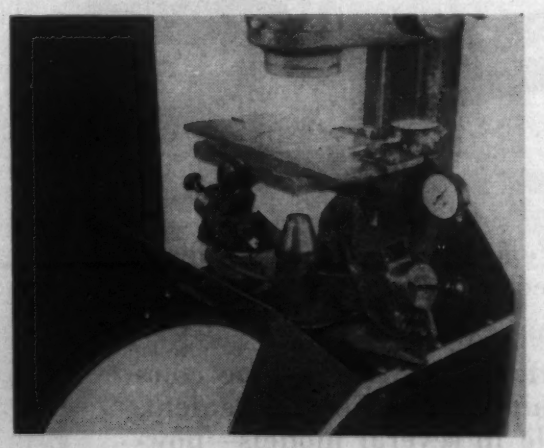
The device consists of a cast metal cylinder housing a plunger connected with a toggle clamp. Pivoted to the base, the cylinder can rock freely to conform with the changing angle of this plunger as it moves back and forth activated by the air.

It operates on the shop airline pressure of 40 to 150 lbs., and can withhold a constant pressure of 325 lbs. at the end of the clamping bar. Air is used solely to actuate the clamp, it being the toggle that locks the clamp and holds the work firmly. A 90 deg. swing of the clamping bar facilitates the placing and removing of parts in fixture. Because of the compact size and low weight of 1¾ lbs., it is convenient for cramped spaces.

Optical Comparator

The co-ordinate stage of a new Portman optical comparator is larger than on previous models, resulting in greater mechanical capacity. Larger dial faces on indicators result in increased precision measurement control.

Another feature of this comparator, made by the *Portman Machine Tool Co.*, 70 Mill Road, New Rochelle, N. Y., is the "Shaft-of-Light" blower cooled lamp housing with



a larger condenser lens, providing for sensitive light beam adjustment.

This Model P2-14 may also be had with a plain work stage unit for production jobs or where coordinate measurements are not required. Magnification lens units of 10, 20, 31¼, 50, 62½ and 100 X are obtainable as standard equipment. It is furnished with a 14½ in. diam. image screen, weighs 400 lbs., is 60 in. high, and occupies space of 24 x 30 in.

★ **Forms a highly-glazed, protective, monolithic surface**

Brickseal is the only refractory coating we know of which consists of high-fusion clays and metals combined with oils. Unlike air-set washes which form only a plaster-like coating on the refractory surface, Brickseal actually becomes an integral part of the brickwork. The heat of the furnace drives out the oils and vitrifies the clays and metals, penetrating deeply into brick pores, cracks and joints, and forming a highly-glazed, air-tight, monolithic wall.

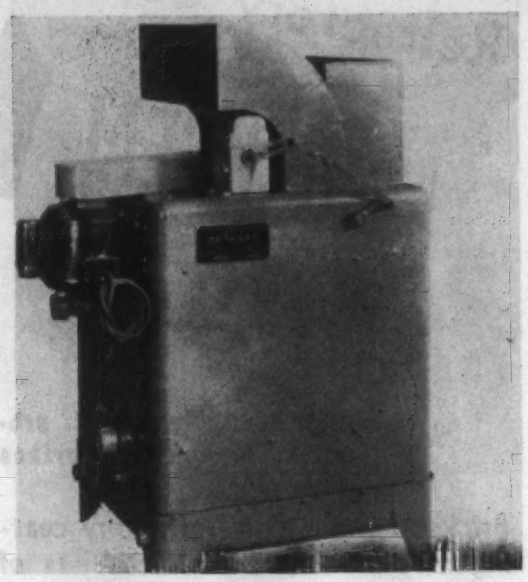
Brickseal cannot crack, blister or peel off due to sudden temperature changes because it remains semi-plastic until the furnace cools, when Brickseal becomes hard as steel. Furnace can be used immediately after Brickseal application. The glossy Brickseal surface reflects heat, prevents air infiltration, and permits increased production with less fuel. Maintenance expense due to cracking, spalling or erosion is reduced or eliminated entirely with Brickseal. Brickseal is applied easily with brush or spray gun. Its cost is insignificant compared with the results it produces.

Write for sample or Brickseal representative.

BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

Compressed Air Cooling Equipment

Improved equipment for the cooling of compressed air is announced by the *Niagara Blower Co.*, 6 E. 45th St., New York 17, and is called the Aero After Cooler. The cooling results in drier air and prevents water damage to pneumatic equipment, a typical instance being the rusting of metallic shot in blast cleaning equipment.



The machine uses the evaporative cooling principle to obtain the temperatures lower by 10 to 25° F. than conventional coolers. Air, drawn by a fan through a water spray across coils containing the compressed air, is the cooling medium. Temperatures within 10° of the wet bulb air temperature can be maintained.

It produces compressed air that contains only one-half of three-fourths of the amount of water formerly experienced with the best practice. The equipment is also applied to gases generated for industrial use.

Inflammability of Metal Powders

The inflammable characteristics of many powdered metals has been ascertained by the *Bureau of Mines*. During the past year it experimented with 70 samples, including aluminum, antimony, cadmium, chromium, copper, iron, lead, magnesium, tin, zinc and zirconium.

Zirconium, a costly metal used in ammunition primers, is "particularly dangerous." A cloud of such powder ignited spontaneously at room temperature and exploded, whereas other metallic dusts in the "highest explosibility" class required temperatures hundreds of degrees higher before they ignited.

The Bureau recommends that powdered zirconium be handled only as a sludge or in special containers. It is used in welding rod flux, radio tubes, production of armor plate and in furnace refractories.

Some of the experimental work is described in the Bureau's Information Circular 7241, "Annual Report of Research and Technologic Work on Coal, Fiscal Year 1942."

Compound for Aluminum Descaling

"Deox-Aluminum" avoids the severe action of alkalies and acids that etch aluminum and remove much of its surface in aluminum deoxidizing, as applied to stripping and cleaning. Made by *Technical Processes Div., Colonial Alloys Co.*, Philadelphia, it is used as a dip, at room or elevated temperatures, from 10 sec. to 1 min.

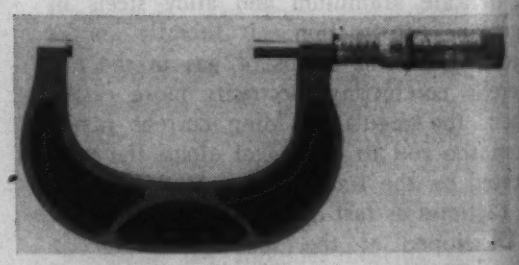
Aluminum is dipped into the "Deox" solution until a uniform grey coat is deposited over the metal surfaces. The work is then rinsed and dipped into 30 to 50 per cent nitric acid at room temperature, this removing the grey coat and leaving the metal chemically clean. The attack on the aluminum surfaces is negligible. The grey coat may be left on as it is galvanically protective, acts as a paint base, prevents oxidation in transit and may act as a solder base.

It can be used on all alloys of aluminum, wrought, cast or forged. It is supplied as salt, to be mixed with water. The bath may serve both as an aluminum anodizing rack stripper and as a general cleaning method. Venting is recommended only at 120 deg. F. or higher.

● Clever techniques have been used to protect Jeep parts for shipment overseas from salt water corrosion, according to *Willys-Overland Motors, Inc.* A new method of combatting condensation within a package is to include a bag of silica gel, which sponges up the condensation. One package is wrapped in heavy paper, then dipped in hot wax, thus leaving a transparent airtight coating entirely impervious to water. In shipping these parts more than 70,000 rust-proof cartons of 250 different sizes are used each day.

Micrometers Graduated in "Tenths"

Henceforth all Reed micrometers, in the 1, 2 and 3 in. sizes, will be furnished with a vernier enabling quick and easy readings to 1/10000 in., at no extra price, states the



sales agent, *George Scherr Co.*, 128 Lafayette St., New York 13, N. Y.

This addition was made to conform to the greater precision and closer tolerances demanded in today's war manufacture.

IF THERE IS A FLAW "FLASH-O-LENS" WILL FIND IT!

The new FLASH-O-LENS offers foundry-men, machinists, and many others engaged in producing metal parts for war contracts an efficient, economical means of examining the most minute defects during routine inspections.

FLASH-O-LENS consists of a portable 40x microscope combined with a perfect source of illumination in one convenient, compact unit . . . They are available in several models—powered by either standard flash light dry cells or by current from any AC or DC outlet—and with a selection of various combinations of lenses, all interchangeable in the one lens housing.

Send today for illustrated catalog describing the new FLASH-O-LENS

E. W. PIKE & COMPANY — PIKE

Manufacturers — ELIZABETH, N. J.

On the job 24 HOURS EVERY DAY

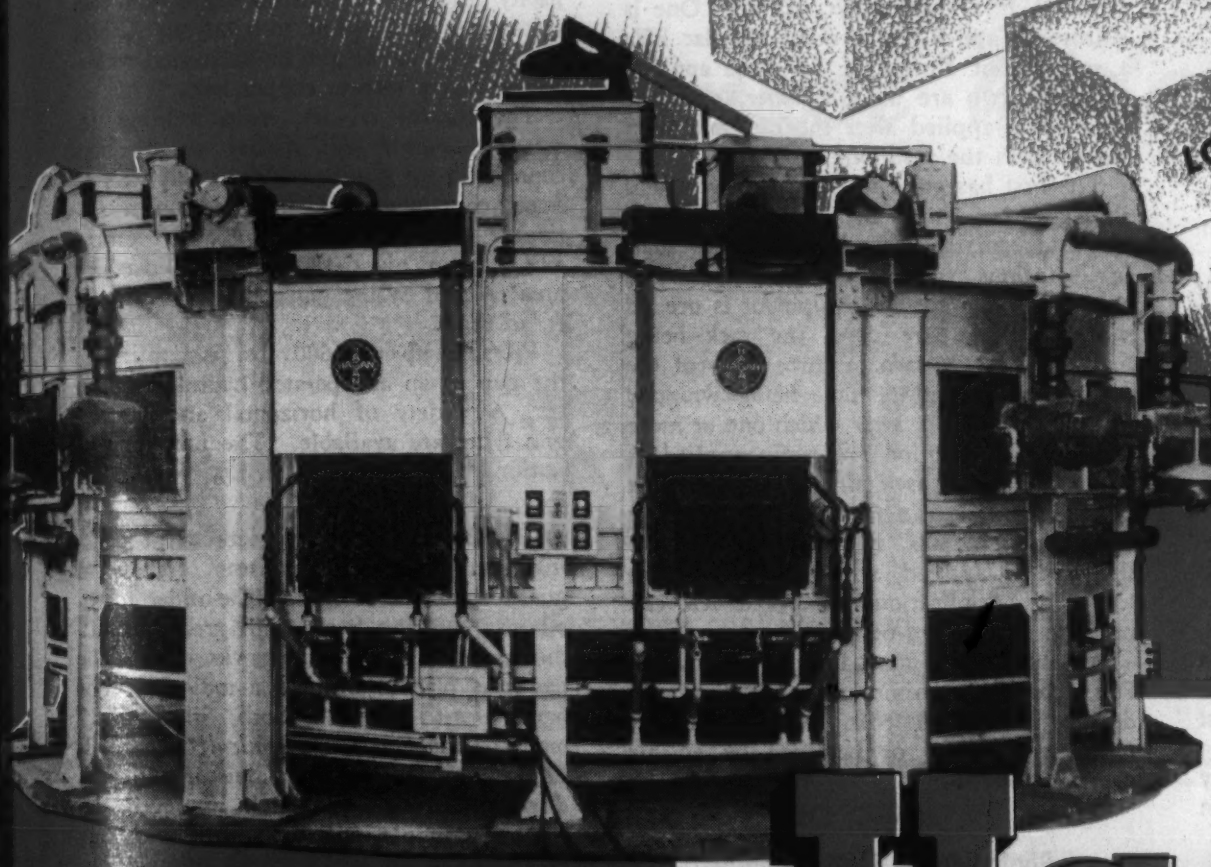
SHORTER HEATING TIME

LOWER FURNACE TEMPERATURE

UNIFORMLY HEATED BILLETS

FEWER REJECTS

LOWER FUEL CONSUMPTION



HAGAN INDUSTRIAL FURNACES FOR ALL PURPOSES

PLUS *features:*

- HAGAN patented hearth construction keeps maintenance costs low, lost furnace time is negligible.
- ★ HAGAN method of firing with accurate time and temperature control — every billet forges the same, cold or burned steel is eliminated.
- ★ Lower fuel costs with HAGAN Rotary Hearth Furnaces, lower operating temperatures, less heating time, scale losses are lower.
- ★ HAGAN furnaces are charged and discharged at one central point, labor costs are therefore lower.
- ★ Die life is increased, constant uniformity of heated billets.

Hagan

ROTARY HEARTH FURNACES

On the job, 24 hours every day keeping America's leading forge plants supplied with a continuous flow of uniformly heated billets. EVERY billet forges the same,—when they are heated in a *Hagan* Rotary Hearth Forging Furnace. Burned or under heated steel is eliminated through the control of time and temperature during the entire heating cycle.

Do you have our descriptive bulletin?

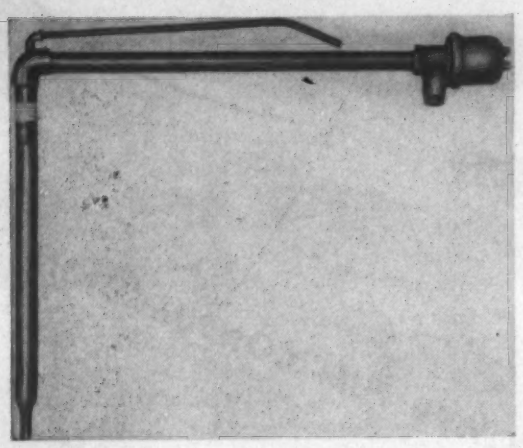
GEORGE J. HAGAN COMPANY

PITTSBURGH, PA.

DETROIT CHICAGO LOS ANGELES SAN FRANCISCO

Vent-Type Thermocouple

A new vent-type thermocouple for liquid bath furnaces has been developed by *Claud S. Gordon Co.*, 3000 S. Wallace St., Chicago. It eliminates the collection of gases and reduces contamination to a minimum.



A vent at the top allows gas to escape and, by artificial circulation, admits the right amount of pure air to take its place.

In some cases, an air connection is made with the blower and a very small amount of air circulated through the tube.

Where used in liquid baths, such as cyanide and salts, this vent-type thermocouple increases by two or three times the life and efficiency of the thermocouple.

● A new thermoplastic coating for application on metal, concrete or wood is Amercoat No. 33, made by the *American Pipe & Construction Co.*, P. O. Box 3428, Terminal Annex, Los Angeles. It is a liquid plastic, cold-applied by spray or brush, and is a combination of the most inert synthetic resins obtainable. Among its many uses are protection of machinery and equipment in chemical plants from corrosion by acids and caustics.

Bi-Metallic Battery Cans

A new development in the electrical battery field is the "O.J.B." bi-metallic battery can, which brings about a considerable economy in zinc. Present battery cans have to be at least 0.01 in. thick to enable forming into a can and protect against premature perforation. However, only a mere fraction of the zinc is consumed in the lifetime of the cell.

Andersen & Bruun (British) Ltd., Edinburgh Ave.—Trading Estate, Slough, Bucks, England, make a can of two sheets of metal foil, an external one of lead and internal one of zinc, formed into a cup by folding along a multitude of radial folds compressed into a substantially smooth surface with the two portions securely interlocked along the pleats. Thus, there is no limit to the thinness of the metal sheets employed, and the thickness of the zinc sheet can be exactly adapted to the actual zinc consumption in the creation of electrical energy and the local action.

Perforation of the zinc, even at several points, does not affect the further function of the cell, due to the protective lead cover. No seepage of electrolyte can take place, and the cell is useful until all the zinc has been consumed.

● Vapor degreasing has been used principally only for external cleaning where the parts or assembly could be placed in a degreasing machine. However, the Model 35-S Dee Tee vapor cleaner of the *Circo Products Co.*, 2835 Chester Ave. at E. 30th St., Cleveland, has sold a few portable units for internal degreasing of machinery gear cases and enclosed transmissions, oil reservoirs and lines, heat exchangers, etc.

Coverings for Plating Racks

Two new products for covering plating racks, widely used in many varied industries, made from Koroseal, are a plasticized polyvinyl chloride thermoplastic material, states *B. F. Goodrich Co.*, Akron. One is Koroseal Tape RX, the other Koralac RX, a solution of Koroseal. In some applications the two are used together, with the tape being applied after the rack has been coated with the solution.

The first has good resistance to wear and abrasion, has excellent insulating properties and remarkable resistance to all plating solutions, such as chromic, alkali and acid dips. No special equipment is needed when the two are used, the rack being first treated with two or three coats of the solution and then the tape being wrapped under firm tension, after which one or more coats of the solution are again applied.

If the tape is used alone, the rack must be placed in an air oven with a minimum temperature of 300° F. for two hours after the tape is applied, which fuses the tape together. Application of Koralac RX can be done by dipping or painting.

All sharp edges must be filed or ground. Four coats are minimum, with thorough drying after each coat, accomplished at room temperature or hastened by an air oven at 150° F.

Photoelectric Flame Monitor

A photoelectric system for providing instantaneous fuel cut off in any pressure-fed burner in the event of flame failure, is announced by *Combustion Control Corp.*, 77 Broadway, Cambridge 42, Mass. Called Fireye, type F28C, it can monitor a flame of any intensity, and is applicable to oil, gas or pulverized coal burners. It operates from direct observation of the flame rather than from such secondary flame characteristics as temperature or electrical conductivity.

It is mounted directly on the furnace wall and watches the flame through a window in the wall of the fire chamber. It is used with manually ignited burners to cut off fuel and sound an alarm; or, when the burner is fired automatically, to program fuel pump and valve operation, intermittent ignition system, purging period and recycling.

Once the lens of the optical system has been aligned, the field of vision of the electric eye is limited to the flame itself and extraneous light is rejected. While the electric eye sees flame, Fireye feeds fuel to the burner. Should flame fail, or any condition impairing safe operation develop within the electronic control, it cuts off the fuel supply until proper combustion conditions are restored.

Stored-Energy Gun-Type Welder

What is believed to be the first successful application of the stored energy principle to a portable gun-type welder, is the type PS2R-1 welder, developed by *Sciaky Bros.*, 4915 W. 67th St., Chicago 38.

Crowded and fixed jigs can be reached easily with this new radial-type gun spot welder, specially designed for aluminum and light alloys. Tacking and structural welding on large or fixed aluminum structures can be done with greater speed and efficiency.

The welder is rated at 100 kw. and has an aluminum capacity of from two thicknesses of 0.016 in. up to 0.064 in.; a capacity on corrosion resisting steels from two thicknesses of 0.016 in. to 0.080 in. Cables are mounted to the gun on horizontal water-cooled heavy section copper bars.

The control cabinet, main welding reactor, monorail and special copper bars connecting the gun to cables are all built as a self-contained unit, mounted on a stationary column and pivoting on a vertical axis. It can pivot 180° and the machine area reached by the gun is a half circle, 23 ft. in diam.

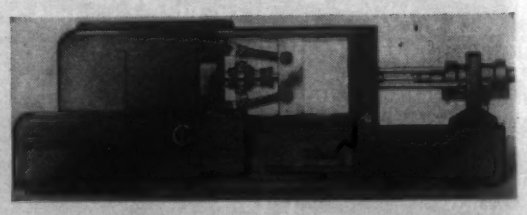
Pressure up to 1600 lbs. is applied to the gun by an air-operated hydraulic booster. A variety of horizontal and vertical gun types are available. The unit may be stationary or buggy-mounted.

● There have been two methods of packing munitions for overseas arenas to guard against corrosion. The older method was slushing items with grease or oil, though de-slushing was awkward. The newer is placing them in a moisture-proof barrier with "Protek Sorb Silica Gel," made by the *Davison Chemical Corp.*, Baltimore 3. This absorbs moisture without dissolving itself. Research has even developed a simple indicator which, by change of color, shows whether the relative humidity is above the danger point.

Die Casting Machine

A large capacity 3G high-pressure cold chamber die casting machine, equipped with Vickers 2000-lb. pressure hydraulic pump system has been developed by *Reed-Prentice Corp.*, Worcester, Mass.

The movable die plate mechanism can be adjusted through electric motor and



screws to accommodate different thicknesses of dies. The machine can be operated either manually or semi-automatically.

Specifications are: Size of die plates, 30 x 30 in.; clearance between top and bottom frame members, 29 in.; mold opens, 16 in.; maximum die thickness, 24 in.; minimum die thickness, 12 in.; mold closing pressure, 600 tons; length by width by height, 203 x 64 x 72 in.; weight, 14 tons; motor required, 1200 r.p.m., 40 h.p.

Little "Bob Upandown" says:—

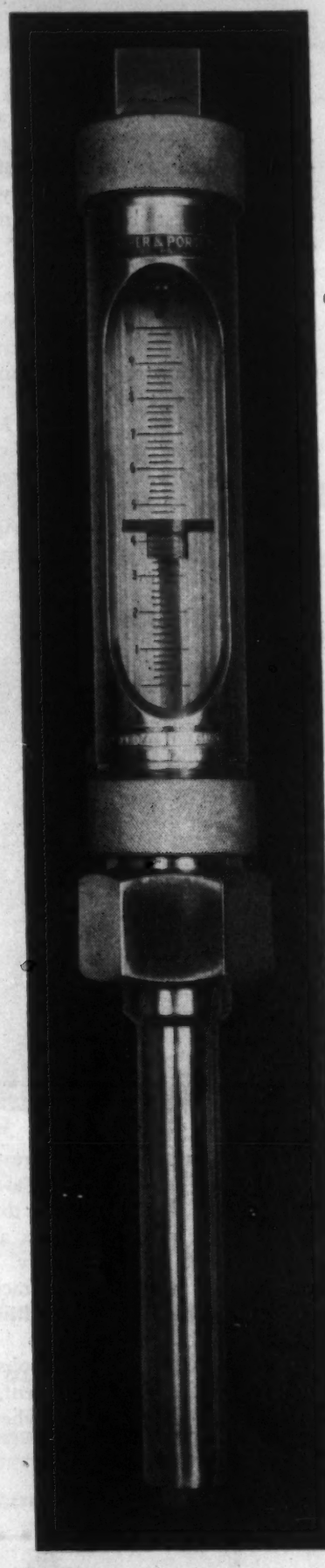
DIRT

cannot hide

IN THE

Furnace Flow Guide

For your peace of mind when seeking good annealing or carburizing results, the Furnace Flow Guide has been made with a *transparent* flow rate metering tube. Study the photograph at the right and note how clearly the flow-indicating float can be seen. Dirt shows up the instant that it starts to collect, and the meter is readily cleanable by unscrewing the bottom extension. Furthermore, discoloration of the oil in the bottom dashpot (for eliminating flow pulsations) in no way interferes with reading of the flow rate. Why guess with concealed orifice plates or solid metal tube flow meters, when you can obtain such *continuous* high accuracy with the Furnace Flow Guide. It is rapidly replacing old style meters in up-to-date plants. For full particulars that will interest all those responsible for the annealing or carburizing of critical war products, write for our bulletin 30-C. Sent without any obligation at your request.



Photograph of the Furnace Flow Guide specially designed for measuring flow rates of gases or liquids to inert gas generators, and annealing or carburizing furnaces. The type shown has an oil-filled dashpot extending from the bottom by means of which severe flow pulsations may be successfully dampened.

FISCHER & PORTER CO.

6612 COUNTY LINE ROAD, HATBORO, PA.

RATE OF FLOW INDICATING RECORDING OR CONTROLLING ROTAMETERS FOR ANY LIQUID OR GAS

News of Men, Societies, Meetings and Companies

Plants and Slants

Photography is used to a highly developed extent in production, inspection, instruction, etc. at the plant of the *Joshua Hendy Iron Works,* Sunnyvale, Calif., world's largest builder of marine steam engines. Thus, more than 175 sub-contractors furnish parts to Hendy.

When any parts arrive, damaged in transit or otherwise imperfect, photos are taken and mailed to the sub-contractor, thus forming a permanent, visual and convincing record. It is a case where "one picture will tell a thousand words." Moreover, the pictures often aid the sub-contractor to change his production technique to avoid such mistakes in the future.

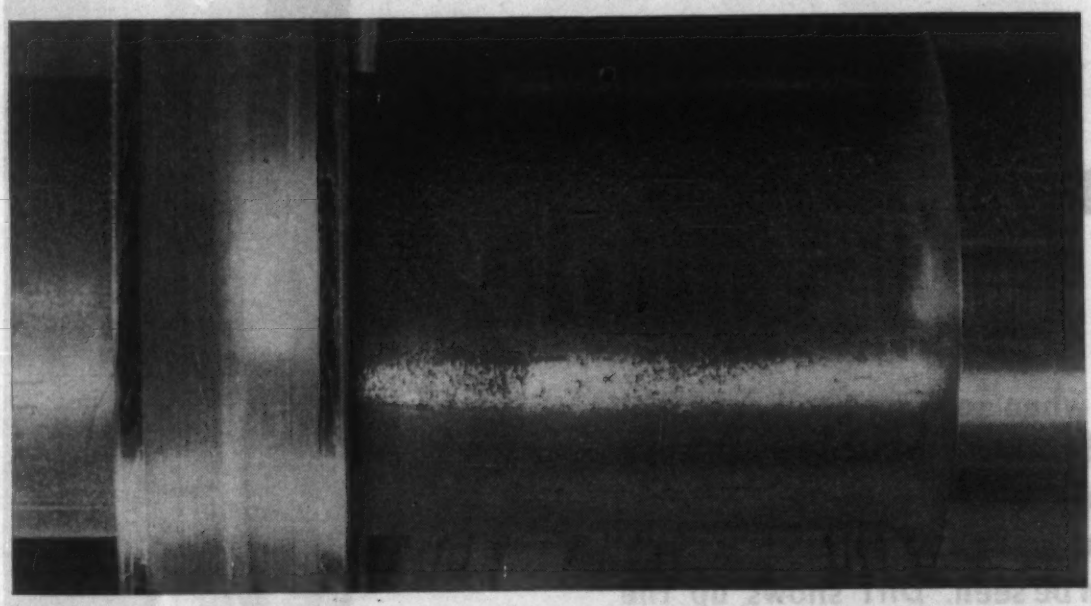
Often parts received from sub-contractors are not seriously enough damaged but that brazing or patching can be resorted to, in which case "before" and "after" photos are taken for the record and distributed to all interested parties. On an average, five salvage photos are made daily. The problem of showing hair-line cracks in castings often requires special lighting and precise location of the lights.

Complete sets of photographs depict all Hendy facilities and equipment, helping a prospective customer decide whether Hendy can do the special job that he wants.

Many of the inexperienced help cannot read blueprints readily. Various steps of a machining or fabricating process are photographed, blown up to 11 x 14 in. and lacquered, then placed over the respective position at the assembly jig.

A progressive study of various heat treatments on gear-cutting hobbers was made successfully by photography. Through this study of changes in cutting oils, varying degrees of hardness of hobs, etc. a standard was finally developed. Most of these photos were enlarged from 10 to 50 times to bring out the detail of the tooth surface.

Another use was in the determination of scale-removing efficiency of various solvents used to clean castings. A photographic study of welds revealed that a pre-heat treatment at 400° F. was as effective as at 500° F.



In the accompanying photograph is a journal pin of a turbine drive shaft while being tested with a Magnaflux inspection apparatus. Flaws are revealed magnetically and show in the photographic records.

A new aluminum forge plant was opened around Nov. 1 by *Chevrolet Motor Co.* at Anderson, Ind., the new unit being the fourth of its type in the Chevrolet's system. The forgings go principally into *Pratt & Whitney* engines for bombers and cargo planes.

The *Inland Steel Co.* observed its 50th anniversary the week of Nov. 1, employees meanwhile working without interruption. From its beginning in 1893, with 40 carloads of miscellaneous machinery and no plant, the company has developed into a completely integrated producer of steel, now pouring 3,400,000 tons a year. The company celebrated its half-century anniversary by producing a record tonnage of ingots in October, or 2,738 net tons more than its previous record of last March.

Allegheny Ludlum Steel Corp., Brackenridge, Pa., has acquired the *Carbide Alloy Corp.*, New York, and will be operated as Ludlum's carbide division. Initial products will be a line of highly-developed cemented carbides.

Rotary Electric Steel Co., Detroit, has been purchased by *American Co.*, subsidiary of *Atlas Corp.* Operations will continue under the same name and operating organization, employing 1000, the products being electric furnace alloy steels.

An entire year of steelmaking without a single lost-time accident in any department was chalked up by the Wood Works, McKeesport, Pa., *Carnegie-Illinois Steel Corp.*, as of October 29. New employees since the first of the year are 10 per cent of the total force, but they are early schooled in safety precautions.

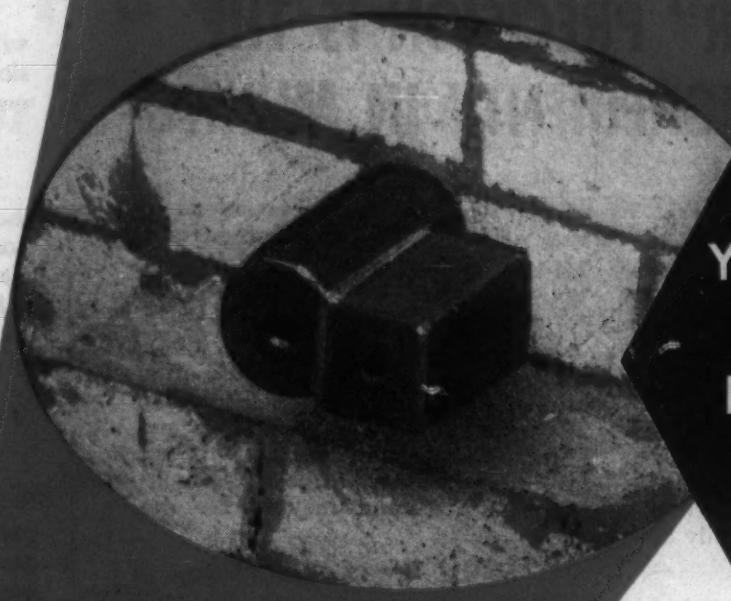
The *Pennsylvania Salt Mfg. Co.* has bought the famous Whitemarsh Hall in Philadelphia, former residence of the late Edward T. Stotesbury, which will be converted into a scientific research laboratory. Its 150 rooms will house 75 chemists and their assistants.

Announcing the NEW

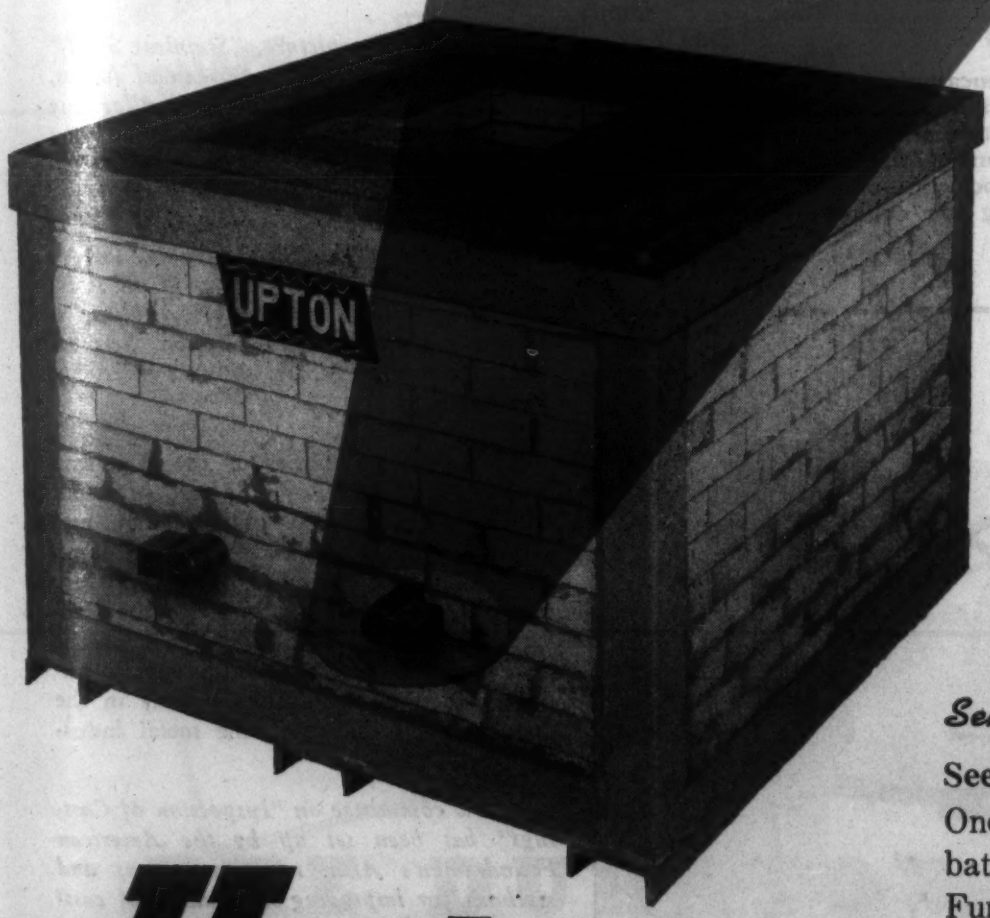
SEALED-ELECTRODE Salt Bath Furnace

The Greatest

ADVANCE IN THE DESIGN AND CONSTRUCTION OF SALT BATH FURNACES



You Need Not Replace this Electrode It is Bricked-in Permanently



- *Eliminates all necessity for changing electrodes*
- *Improves operating efficiency*
- *Faster starting*
- *Cheaper hold-over*
- *Permits vertical hardening of long tools*
- *Small production treating of small tools*
- *Work cannot be burned*
- *No "down-time" for changing electrodes*
- *No material costs for new electrodes*

Send for complete information now.

See this furnace in actual operation in Detroit. One of the largest commercial heat treaters has a battery of the New Sealed-Electrode Salt Bath Furnaces in operation. Available for your inspection at anytime.

Upton ELECTRIC FURNACE DIV.

UPTON Electric Salt Bath Furnaces are available for Every Metallurgical Heat Treating Requirement from 300° to 2500°

7425 MELVILLE AT GREEN DETROIT 17, MICHIGAN

Lancaster MIXERS

THE SCIENTIFIC COUNTER-CURRENT RAPID BATCH MIXING SYSTEM

"LANCASTER" PRECISION IS THE "PRICELESS INGREDIENT" IN MIXING

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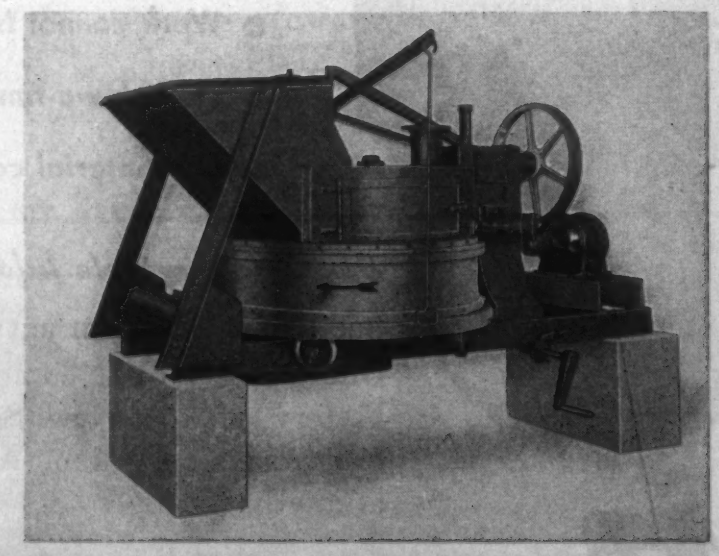
Lancaster Mixer, Symbol EMG-4, closed pan type, fitted with full batch stationary hopper.



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BRICK MACHINERY DIVISION

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The *Ferracute Machine Co.*, Bridgeton, N. J., has published an attractive booklet commemorating their 80 years of existance. The photographs are excellent, the history is interesting and, like the city of Chicago, Ferracute went through a "big fire."

All physical assets of *Coated Products Corp.*, Verona, Pa., have been purchased by *Koppers Co.*, and the business will continue without interruption.

The *Cleveland Co-Operative Stove Co.* will henceforth operate its foundry division, maker of gray iron and semi-steel castings, as the *Cleveland Foundry Co.*

The Maritime "M" has been awarded the *Phelps Dodge Copper Products Corp.*, Los Angeles Tube Div. Recently this plant received the Army-Navy "E." Only a limited number of plants have received both awards.

Briefs on Associations, Promotions, Education

W. W. Galbreath has been appointed executive vice-president of the newly-organized Pressed Metal Institute, headquarters for which has been transferred from New York to 829 Union Commerce Bldg., Cleveland. For many years president of Alliance Porcelain Products Co., Mr. Galbreath is well known in steel and stamped metal industries.

A new motion picture, "Stainless Steel," has been released by the Bureau of Mines, taken in cooperation with the Allegheny Ludlum Steel Corp. The picture shows the electric furnace charged with raw materials, the addition of carefully measured amounts of chromium and nickel. The charge begins to melt and bubble, sample ingots are taken, the ingot goes to the soaking pits, rolling mills, etc. Application should be addressed to Graphic Services Sec., Bureau of Mines, 4800 Forbes St., Pittsburgh 13.

At the annual dinner of the American Society for Metals, Roy A. Hunt, president of the Aluminum Co. of American, and Dr. Zay Jeffries, technical director, lamp dept., General Electric Co., Cleveland, were awarded medals, the former for the "advancement of research," and the latter the gold medal for his "outstanding metallurgical knowledge and great versatility in the application of science in the metal industry."

A new committee on "Inspection of Castings" has been set up by the American Foundrymen's Assn. to stress means and methods for improving the quality of castings from the purchasers' point of view. There are seven members, for which no chairman had been appointed at this writing.

A technical film describing processing methods for magnesium alloys has recently been released by the Dow Chemical Co. It deals with machining, welding, forming, riveting and surface treatment of magne-

DURASPUN CENTRIFUGAL CASTINGS

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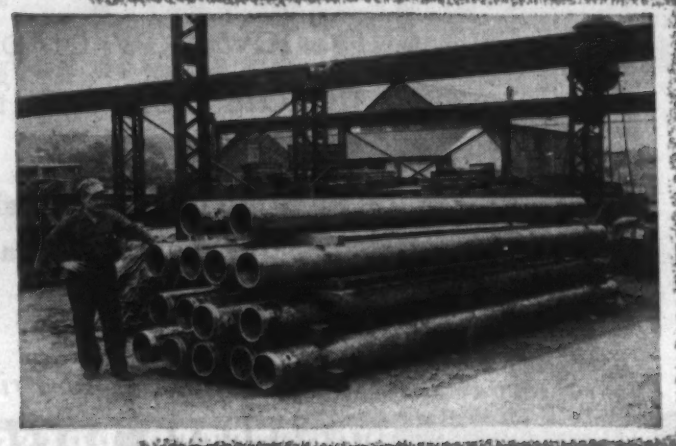
The Superior Castings for Tubular Products



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To get more fully acquainted with Duraloy's service on centrifugal tubular castings, why not send for our Bulletin 4227-C?

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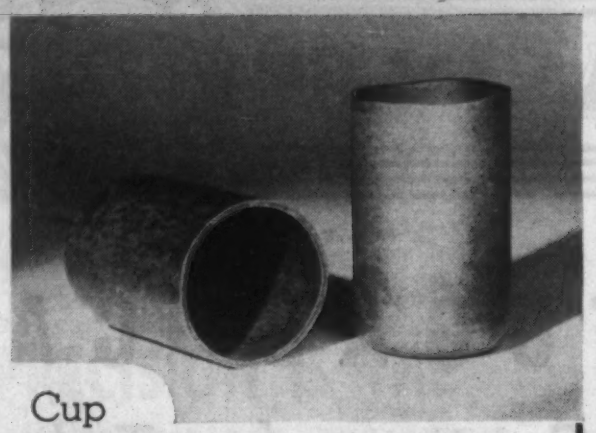

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sium. Requests should be addressed to the company at Midland, Mich.

The next National Metal Congress will be held at Cleveland, Oct. 16-20, 1944, the displays being held in the Public Auditorium, as in 1942. Floor layouts for the 1944 Congress will be completed early next year. Official attendance at the 1943 Congress was 23,294.

A sound motion picture, "If It Happened Here," depicting a typical plant protection organization, has been completed by Bethlehem Steel Co. It includes simulated incidents involving first aid, rescue and demolition work. Pertinent dialogue and plant noises make the film realistic.

The American Welding Society presented several medals at its annual meeting in Chicago in October. Dr. David S. Jacobus, retired consulting engineer, Babcock & Wilcox Co., Barberton, Ohio, received the Samuel Wylie Miller memorial award "for the most conspicuous contribution to research, standardization and advancement of welded construction." Gilbert E. Doan, Robert B. Stout and John H. Frye, Jr., all professors of metallurgy at Lehigh University, received the Lincoln gold medal for a joint paper which was the "greatest contribution to the advancement and use of welding for the year."

The foundry industry will meet at Buffalo April 25-28 next for the third War Production Foundry Congress. In conjunction will be held the 48th annual meeting of the American Foundrymen's Assn. The annual "Foundation Lecture" will be presented by Dr. H. W. Gillett, chief technical advisor, Battelle Memorial Institute, on "Cupola Raw Materials."

To maintain a low rate of absenteeism the American Can Co. has established in its Amertorp plant a unique Employees Service Bureau. It handles gasoline and special mileage applications; purchase of new automobiles, bicycles and tires; listing of rooms, apartments and houses, etc. The plan is sometimes called: "Being secretary to employees." The management considers it successful.

News of Engineers

Victor F. J. Tlach has resigned as president of Darwin & Milner, Inc., Cleveland, a position which he has held for nearly 30 years, to join American Agile Corp., 5806 Hough Ave., Cleveland, specialists in welding electrodes. He is well known as a pioneer of high carbon-high chromium tool steels, having been connected intimately with their discovery at Sheffield, England. He helped introduce them into the United States.

Morse Hill, assistant metallurgist, Materiel Center, Army Air Forces, Dayton, Ohio, has been transferred into the eastern procurement district, Conservation Branch, New York, to assist manufacturers in conservation of critical materials and use of

2 things shopmen tell us about Bethlehem Carbon Tool Steels

Right through the war emergency shopmen have been turning in enthusiastic reports about the service they're getting from Bethlehem Carbon Tool Steels. They praise these steels chiefly on two counts:

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We've had a lot of shopmen tell us this, by letter and by word of mouth. We'd rather have a good word about tool steel from a shopman than from anybody else, for he's the man who *knows.* He's working with the steel every hour of every day. When he says tool steel is good, *it's good.*

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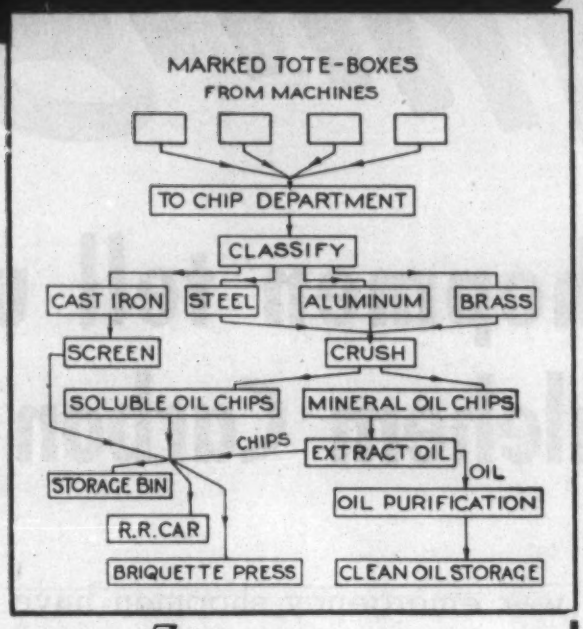

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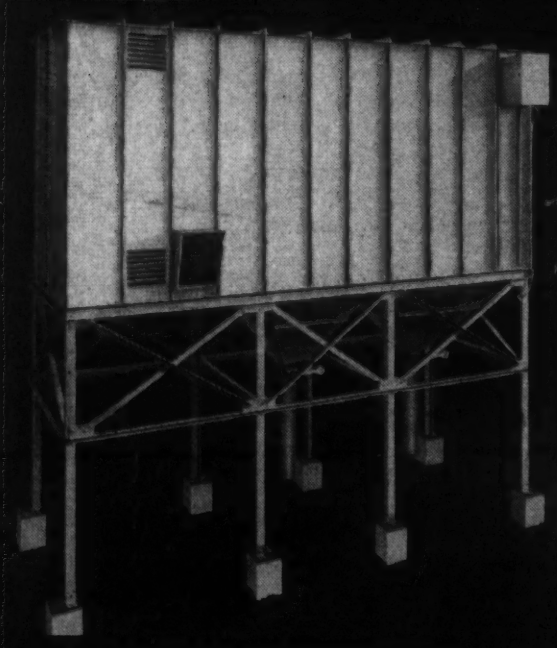

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alternates. He was graduated from the University of Michigan in chemical and metallurgical engineering in 1936, doing post-graduate work later. He has been with Wolverine Tube Co., Detroit.

John B. Ross, formerly with Linde Air Products Co., has been appointed to the West Coast engineering office of Handy & Harman, where he will serve as brazing engineer, making his headquarters in Los Angeles. He is a graduate of the University of California, and has been connected with the gas consuming apparatus field.

John C. Redmond has been appointed research engineer and chief analytical chemist of Kennametal, Inc., Latrobe, Pa. His business inconnections have involved National Bureaus of Standards, Battelle Memorial Institute and Youngstown Sheet & Tube Co.

James R. Weaver, manager of the Louisville plant of Westinghouse, has been made manager of the Naval Ordnance plant at Center Line, near Detroit. He has been in the equipment branch of Westinghouse for many years, and is a former president of the American Society of Tool Engineers.

L. F. McGlincy has been appointed assistant manager of operations, Pittsburgh district, American Steel & Wire Co. *Loren J. Westhaver* has been made general superintendent of the Donora Steel & Wire Works, succeeding Mr. McGlincy. Graduated from metallurgical engineering from the Worcester Polytechnic Institute, Mr. McGlincy has been with his present company since 1924.

Victor P. Shaffer has been named engineer in charge of design for the Process Div., H. K. Porter Co., Inc., Pittsburgh. For the past 10 years he has been associated with design, development and plant layout work for Calco Chemical Div., American Cyanamid Corp.

Clyde Llewelyn has been made vice president in charge of operations, Bliss & Laughlin, Inc., Harvey, Ill., and Buffalo. Previously, he has been engaged chiefly with metallurgical, manufacturing and engineering contact work. *Harry M. Clarke* has joined Bliss & Laughlin at Harvey as metallurgical engineer, having formerly been with Carnegie-Illinois Steel Corp. as metallurgical representative. *Karle D. Meyer* has joined B. & L. as a mechanical engineer, having been with the Peoples Gas, Light & Coke Co.

Dorothy M. J. Tracey, vice president of Tomkins-Johnson Co., Jackson, Mich., has been appointed general manager. She served for several years as purchasing agent.

Grant S. Diamond has become president of Electro Refractories & Alloys Corp., Buffalo. He had been research chemist and plant manager. *Carl F. Leitten* has been made vice president of manufacturing, having been in several operating positions, rising to plant manager. *E. Halsey Brister,* formerly abrasive engineer, has been elevated to assistant plant manager.

(Continued on page 1472)

Season's Greetings

We cannot allow 1943 to become a closed book until we have thanked you for your business, your patience and fine cooperation during the past twelve months.

May your Christmas be ever so joyful and your New Year prosperous and plentiful.

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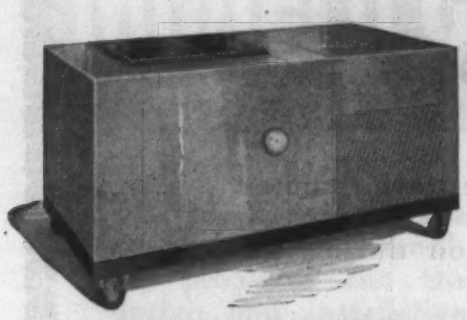
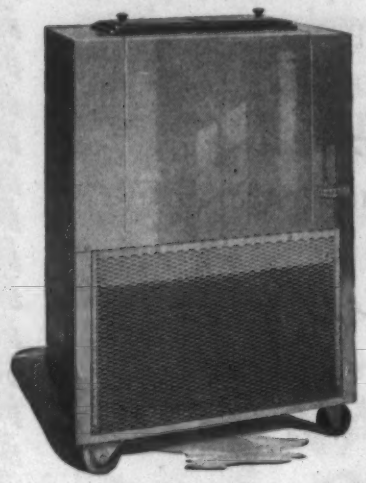


5.4 Cu. Ft. 32" x 34⅞" x 63¹¹⁄₁₆"



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J. M. Darbaker has been appointed assistant manager, Chicago district operations, Carnegie-Illinois Steel Corp. He is succeeded by *Charles A. Ferguson* as general superintendent, having been assistant general superintendent of the Gary sheet and tin mill. Mr. Darbaker rose to his present position through positions such as resident engineer and master mechanic.

Arthur B. Westerman, metallurgist, has joined the research staff of Battelle Memorial Institute, physical metallurgy division, Columbus. Prior to that he was with the metals research laboratory of Carnegie Institute. *M. Ernest Graham* has been appointed to the research staff in its division of non-ferrous metallurgy. He was formerly with the Niagara Alkali Co.

Peer D. Nielson has been made general superintendent, Geneva Steel Co., new U. S. Steel Corp. subsidiary, with headquarters at Geneva, Utah. Until recently he was chief engineer of the National Tube Co., Lorain, Ohio. He has had much experience with the open-hearth furnace.

E. E. Bryant, member of the research staff of Ferro Enamel Corp., Cleveland, for over seven years, has been made ceramic research director. Before joining Ferro he had been with Lisk Mfg. Co., Canandaigua, N. Y.

Eugene W. Nelson, formerly metallurgist with the Timken-Detroit Axle Co., and recently with the Jam Handy organization making industrial training films, has joined Denham & Co., Detroit, industrial advertisers.

Robert G. Glass has been made director, vice president and manager of operations, Geneva Steel Co., Geneva, Utah. He had been assistant manager of operations at the Carnegie-Illinois Steel Corp., Chicago. He started his career with the old Illinois Steel Co. in 1912 in the inspection department.

Meetings and Expositions

NATIONAL CHEMICAL EXPOSITION, New York, N. Y. December 6-11, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. January 10-14, 1944.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. January 25-27, 1944.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, 50th anniversary meeting. New York, N. Y. January 31-February 2, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. February 20-24, 1944.

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Maynard S. Kearney, *District Manager, 1133 Leader Bldg., Cleveland, O.*
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Duncan A. Scott & Co., *Mills Bldg., San Francisco, Calif.*
Duncan A. Scott & Co., *Western Pacific Bldg., Los Angeles, Calif.*

Member Audit Bureau of Circulations

ABP

trends

By Edwin F. Cone

Spectrographic Analysis

"A rainbow seen by a spectrograph helps steelmakers in the open hearth process." A preliminary analysis for residuals is made immediately after the melt down. These residuals may include copper, nickel, tin, chromium, molybdenum, etc. Rapid, accurate analyses are more and more essential not only for the calculation of alloy additions, etc., but also because of the grave scrap supply situation. The postwar period will probably be highly competitive requiring control with even closer tolerances and finer distinctions than now prevail. Spectrographic analysis meets these requirements and will have increasing usefulness in industry.—*The Chemical Digest.*

Lead as a Coating Material

More experimental work has been done with lead lately than has been witnessed in years, according to F. E. Wormser, secretary of the Lead Industries Assn., in a recent address. "Because of this we are now finding lead used as a protective coating material on iron and steel to the largest extent in history and I expect this use to survive the war because it has been proven cheap and effective."

Plating with Cadmium

Cadmium is now being electroplated on base metals in coats more than 50 times as thick as those normally deposited, according to the Electroplating Div. of the du Pont company. Steel sheets, 8 ft. long, over 2 ft. wide and about 1 in. thick are being plated with cadmium by a Wilmington, Del., company. Approximately 30 lbs. of cadmium is being deposited on each of these sheets in a uniform coat about 0.02 in. thick.

Silver Bus Bars

The use of silver as a substitute for copper in bus bars is on the increase. "Most of the silver bus bars are being used in the new aluminum and magnesium plants and to date (Oct. 1) about 20,000 tons of silver bus bars have been certified, saving 16,000 tons of copper."—Howard Coonley, of the WPB.

Future of Electrolytic Tin Plate

Discussing the place of electrolytic tin plate in the post-war period, K. W. Brighton, research chemist of the American Can Co., told the convention of the Electrochemical Society that it is expected that electrolytic tin plate will meet with wide acceptance as containers for coffee, biscuits, shortenings and similar non-processed and noncorrosive products. Whether or not the conservation plates will be used in containers for processed foods such as fruits and vegetables, probably depends on what further research reveals regarding the minimum weight of tin coating which will be required to give a service life equal to that of hot-dipped tin plate, and whether such coatings can be applied more economically by electrodeposition or hot dipping.

Consumption of Lead

As the result of an estimate of the amount of lead used for its chemical properties as compared with its physical properties, F. E. Wormser, secretary, Lead Industries Assn., told a group of technical men recently that about 10 per cent of current consumption was primarily utilized because of the weight of lead, 30 per cent because of its softness, malleability and high corrosion resistance, 24 per cent because of its alloying properties, and 33 per cent for its chemical compounds, with 3 per cent unclassified. Roughly one third of the domestic consumption goes into chemical products.

Zinc for Post-War Use

For many years the United States has had ample smelting and refining equipment to produce sufficient slab zinc to meet its normal requirements. With the expansion of plant prompted by war demands, it is safe to expect that this division of the zinc industry will end the war with old plants modernized and with new plants and additions adequate to meet all consumer needs, said E. V. Gent, secretary, American Zinc Institute, to a group of technical men recently.

Steel Cartridge Cases Save Copper

Steel's most spectacular individual saving as a pinch-hitter for copper and its alloys occurred when artillery cartridge cases were converted from brass. When fully in effect on the production line, says a statement of the American Iron and Steel Institute, this outstanding metallurgical achievement will release 653,000,000 lbs. of copper.

Peacetime Rolled Zinc

The post-war position of rolled zinc will be somewhat similar to its pre-war position, according to E. V. Gent, secretary of the American Zinc Institute. The larger outlets for rolled zinc, such as dry battery cups, fruit jar caps, lithographer's sheets, photoengravers' plates, address plates, eyelets, and hull and boiler plates, are based upon certain characteristics of the metal, and rolled zinc will probably be used for these items in normal tonnages.

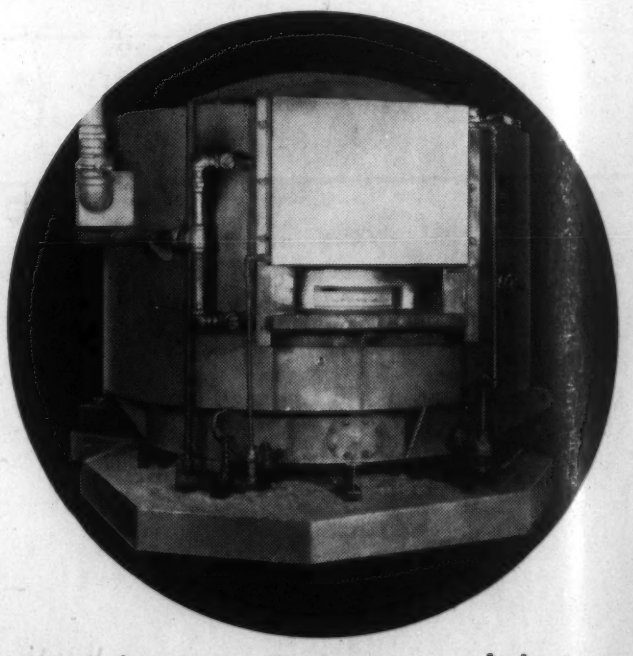
Steel Saves Copper and Aluminum

American steel is saving 559,000,000 lbs. of aluminum and copper (440,000,000 lbs. of copper and 119,000,000 lbs. of aluminum) by pinch-hitting for these metals in a wide range of war weapons redesigned by Army ordnance, according to information made available to the American Iron and Steel Institute by the Ordnance Department of the Army.

METALS and ALLOYS

Metal Production · Metal Working · Materials and Design

- ★ How can spalling be reduced?
- ★ What is the best face coating to prevent slag effect on walls and floors?
- ★ What are the methods and materials used for deep patching?
- ★ How can shallow patching be done?
- ★ How do burner adjustments affect refractory life?
- ★ What are the advantages of highly bonded and air-seal cushioned joints in walls?
- ★ How can the load-carrying ability of floor brick be judged?
- ★ What is the effect upon firebrick life of insulation added to walls and roof?
- ★ How can heat-losses through structural steel be reduced?



B&W Refractories Engineers can help you answer these and similar questions—can thereby help you increase furnace output, and reduce furnace maintenance. They are doing it regularly—as a cheerfully given contribution to the war effort.

THE BABCOCK & WILCOX COMPANY

• Refractories Division •

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R-169

BACK THE ATTACK—BUY MORE WAR BONDS!

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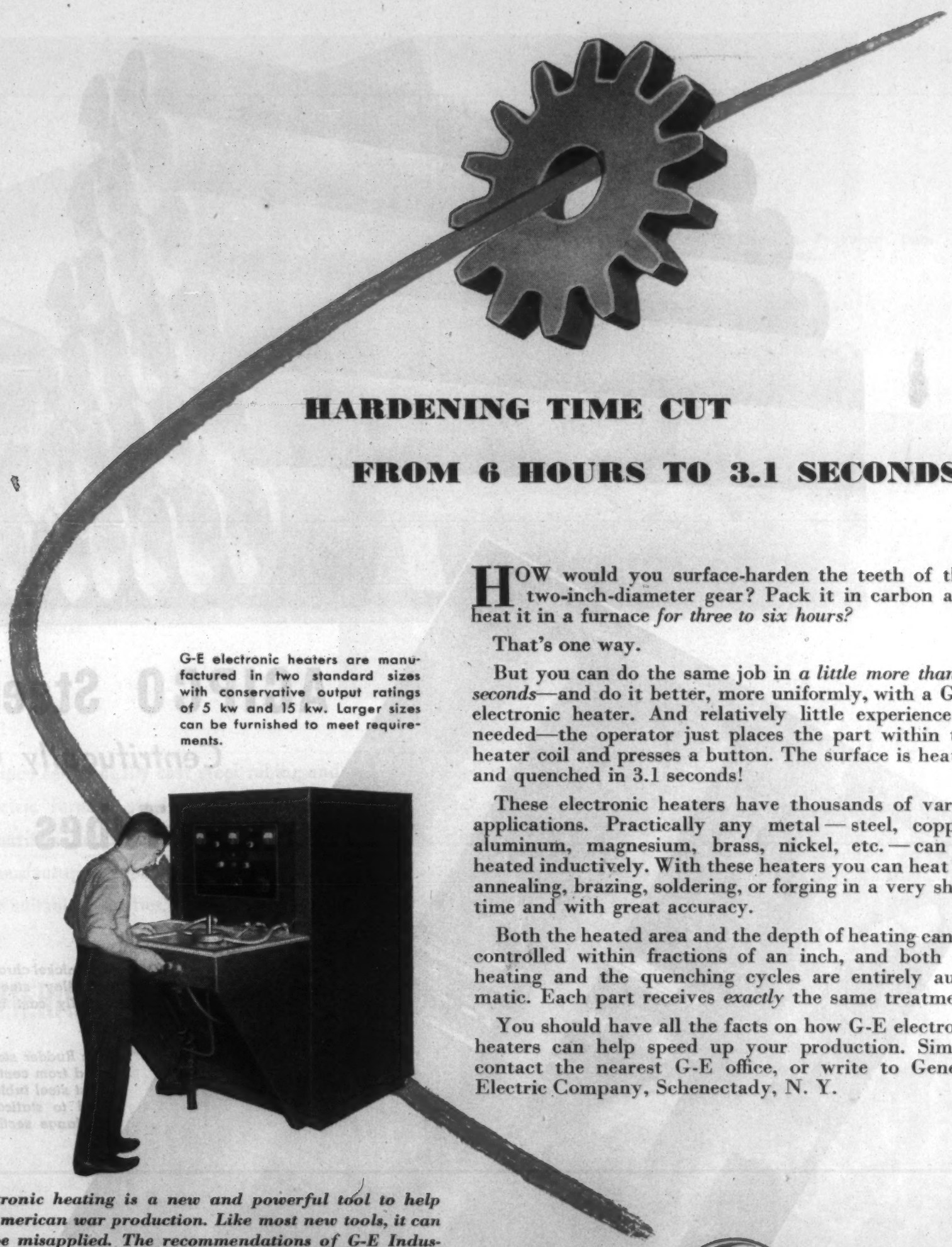

HARDENING TIME CUT

FROM 6 HOURS TO 3.1 SECONDS!

G-E electronic heaters are manufactured in two standard sizes with conservative output ratings of 5 kw and 15 kw. Larger sizes can be furnished to meet requirements.

HOW would you surface-harden the teeth of this two-inch-diameter gear? Pack it in carbon and heat it in a furnace *for three to six hours?*

That's one way.

But you can do the same job in *a little more than 3 seconds*—and do it better, more uniformly, with a G-E electronic heater. And relatively little experience is needed—the operator just places the part within the heater coil and presses a button. The surface is heated and quenched in 3.1 seconds!

These electronic heaters have thousands of varied applications. Practically any metal — steel, copper, aluminum, magnesium, brass, nickel, etc. — can be heated inductively. With these heaters you can heat for annealing, brazing, soldering, or forging in a very short time and with great accuracy.

Both the heated area and the depth of heating can be controlled within fractions of an inch, and both the heating and the quenching cycles are entirely automatic. Each part receives *exactly* the same treatment.

You should have all the facts on how G-E electronic heaters can help speed up your production. Simply contact the nearest G-E office, or write to General Electric Company, Schenectady, N. Y.

Electronic heating is a new and powerful tool to help speed American war production. Like most new tools, it can easily be misapplied. The recommendations of G-E Industrial Heating Specialists are based on the experience gained with more than two hundred installations of electronic heaters plus a quarter century of experience in the development, manufacture, and application of electric heating equipment of all types.

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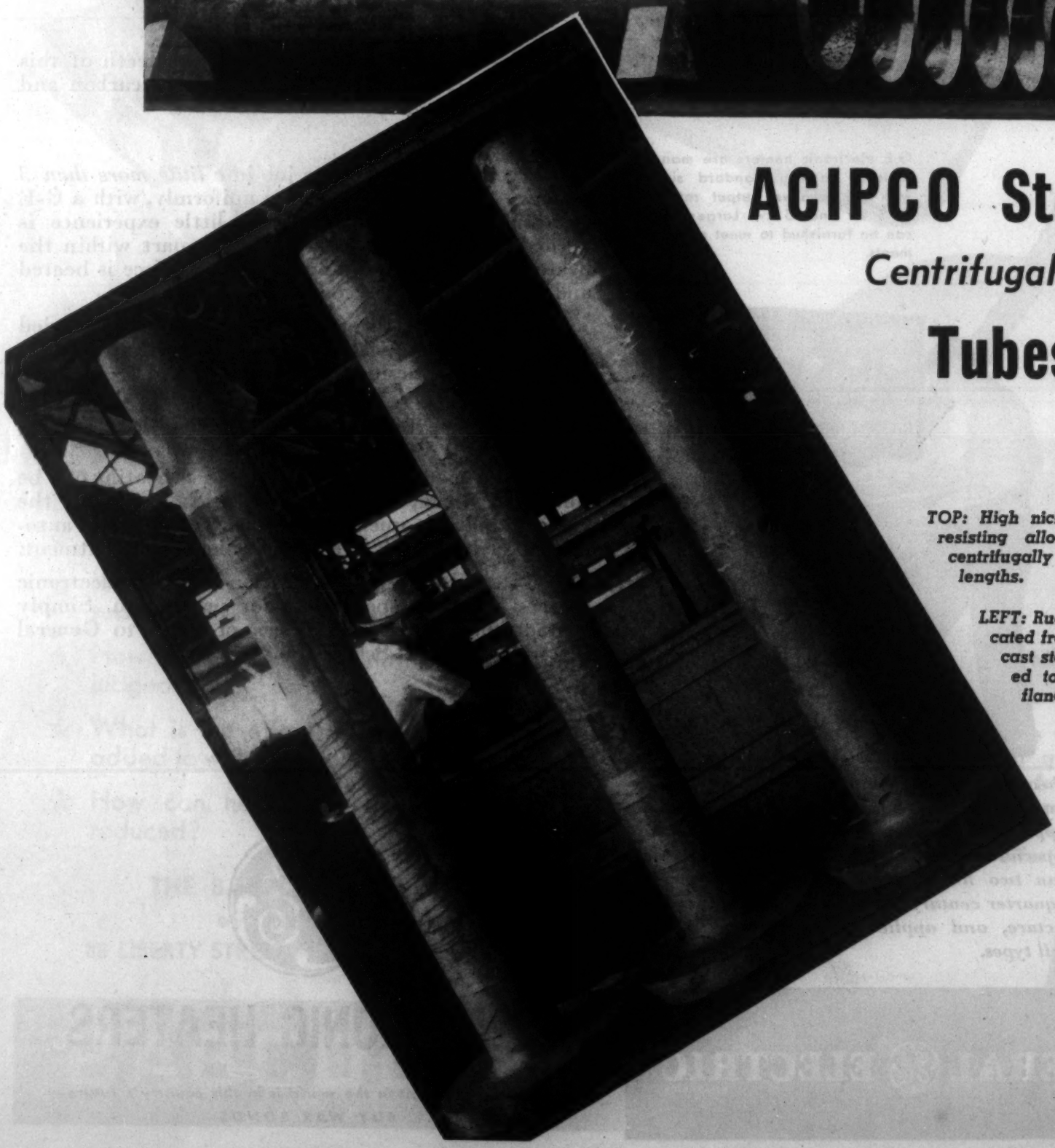
ELECTRONIC HEATERS

The best investment in the world is in this country's future—
BUY WAR BONDS



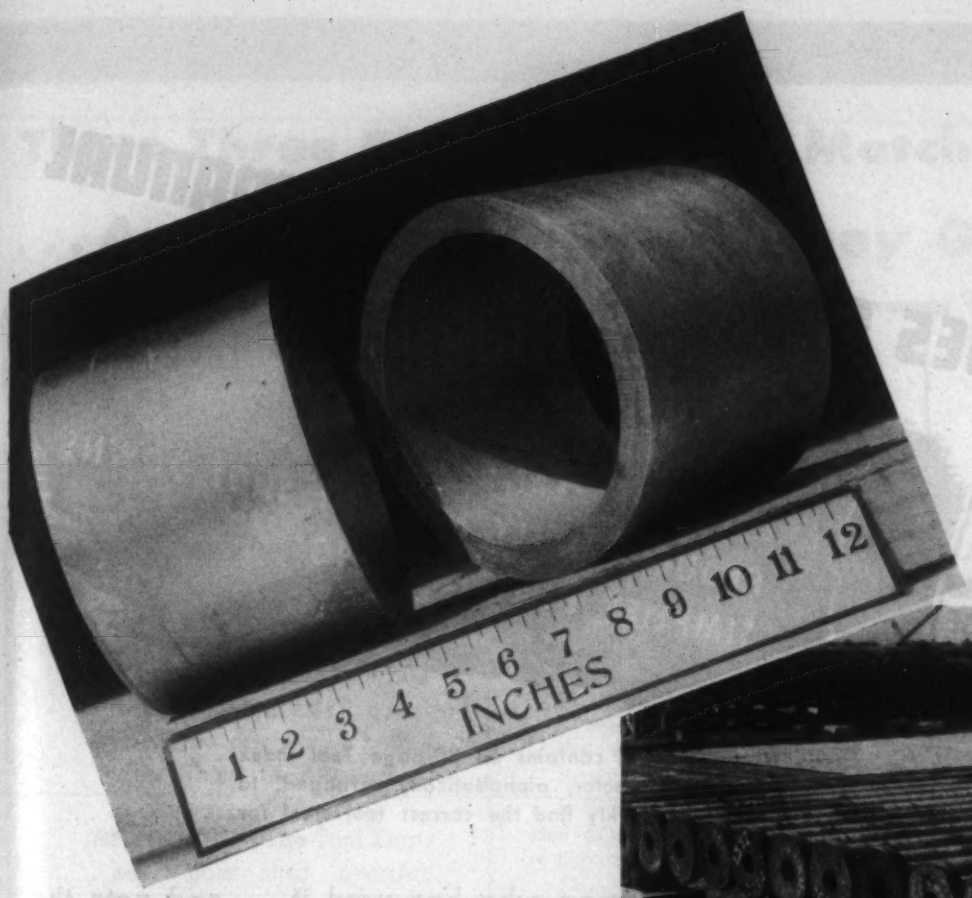
ACIPCO Steel—

Centrifugally Cast

Tubes

TOP: High nickel-chrome heat resisting alloy steel retorts centrifugally cast in 16-foot lengths.

LEFT: Rudder stock fabricated from centrifugally cast steel tubing welded to statically cast flange section.



LEFT—BEARING BACKS: Produced from 16-foot length Type 1015 steel tubes.

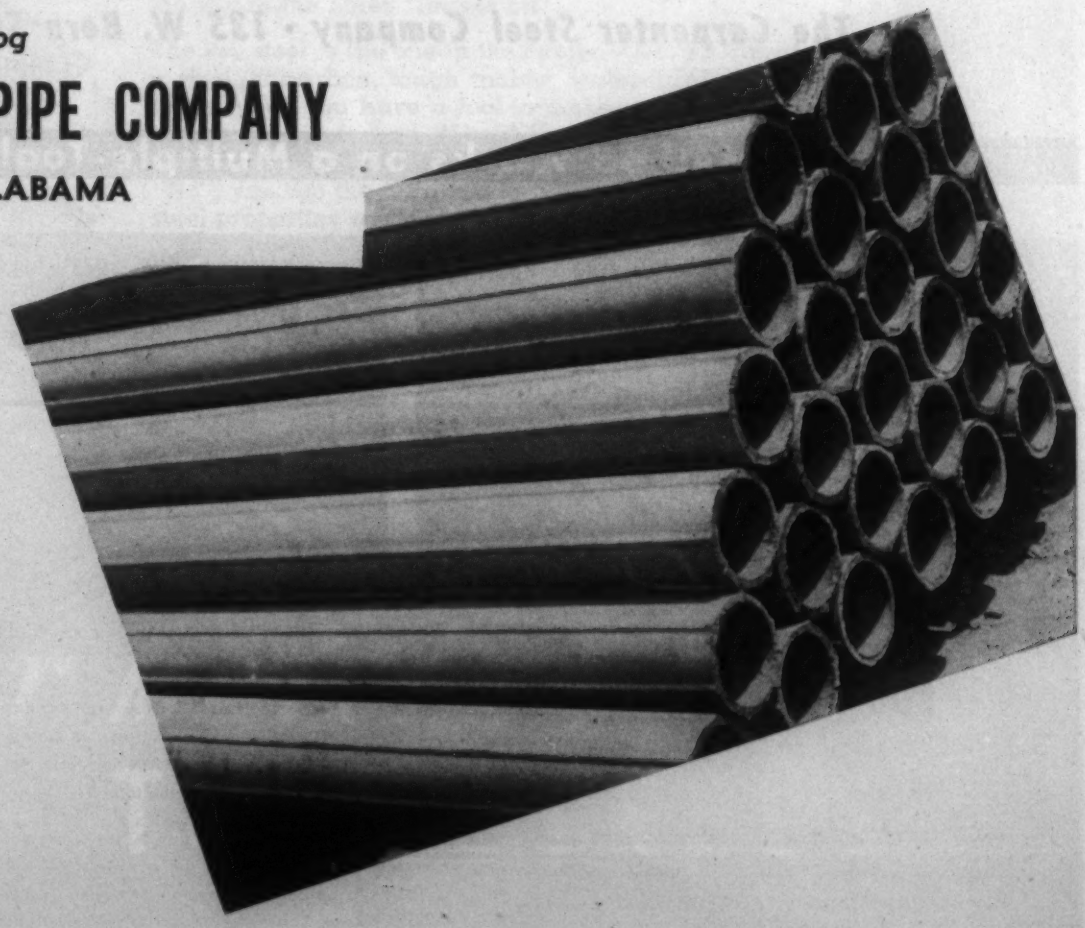
RIGHT—SHAFTING FOR SHIPS: Cast in 16-foot lengths.

Acipco centrifugally cast steel tubing and parts, produced from electric furnace steel, are being supplied in ever increasing quantities under rigid chemical and physical specifications. Manufacturing capacity is available for further production under suitable priorities. We solicit your inquiries.

Write for Catalog

AMERICAN CAST IRON PIPE COMPANY

BIRMINGHAM 2, ALABAMA



RIGHT — FLUTED TUBES: Cast in 16-foot lengths, later to be fabricated into small electric motor stators.

RIGHT FROM THE PAGES OF THIS TOOL STEEL MANUAL

You can find ways to . . .
INCREASE PLANT OUTPUT
REDUCE COSTLY MACHINE SHUT-DOWNS
SIMPLIFY HEAT TREATING

● This Manual contains an 80-page *Tool Index and Steel Selector*, alphabetically arranged, to help you quickly find the correct tool steel for each job.

Idle machines and presses—waiting for tools that must be repaired, reground or replaced—*can* be kept working more hours per month. And the Carpenter *Matched Tool Steel Manual* can help you keep them on the job.

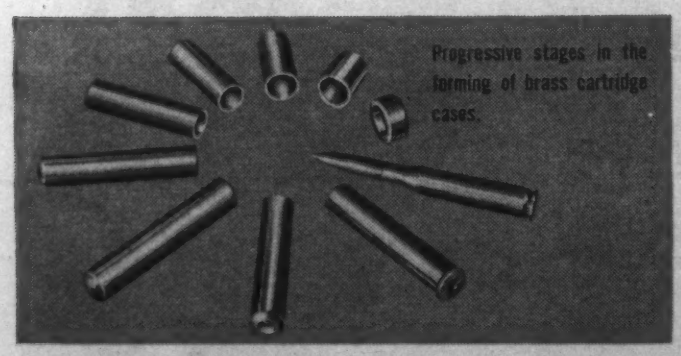
In thousands of plants, this Manual is helping to eliminate costly machine shut-downs. And its simplified heat treating instructions protect the many valuable hours that go into the making of tools.

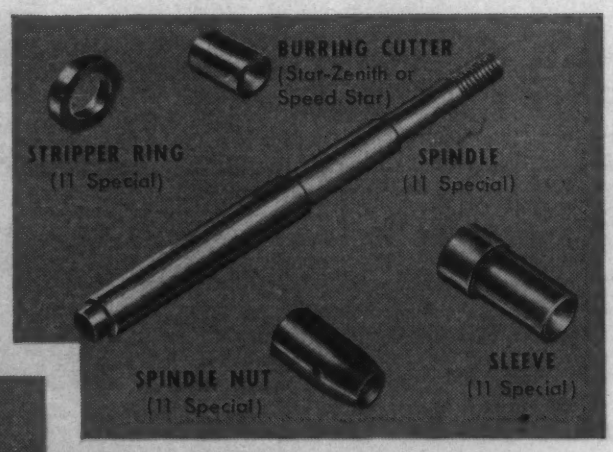
The Carpenter *Matched Set Method* of selecting tool steel is not "just a fancy name". Ask any Tool Room Foreman who has used it . . . and note the *typical* results shown here.

It's easy to cash in on the advantages of the *Matched Set Method*. Just drop us a note on your company letterhead and we'll start your copy of the Carpenter *Matched Tool Steel Manual* on its way. And, of course, when you need personal help with a special tool steel problem, your nearby Carpenter representative will be glad to put his diversified experience to work for you.

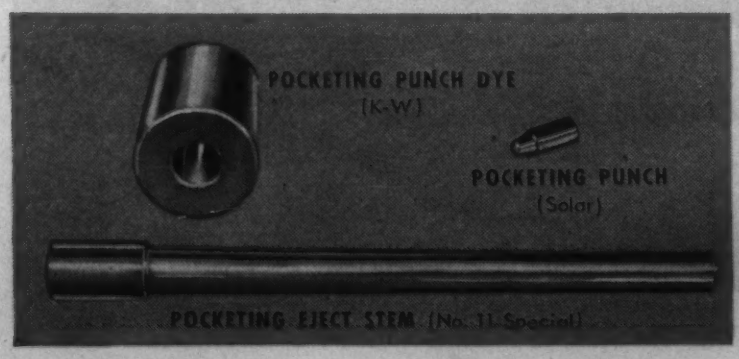
The Carpenter Steel Company · 135 W. Bern St., Reading, Pa.

How This Method Works on a Multiple-Tool Job . . .





FOLLOW THE ARROWS ON THE MATCHED SET DIAGRAM



◆ Tools used for the first trimming cut. The Matched Set Diagram pointed the way to the correct tool steel in each case. Carpenter *Matched* Tool Steels were used throughout, and some of the tools are shown here.

◆ Pocketing punch, pocketing punch die and eject stem—each made for a specific job, and each made from a different Carpenter *Matched* Tool Steel.

The Standard Tool Steels of Industry

These Three Plants Used the Matched Set Method

. . . And Look At The Results They Got!

1

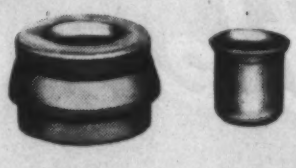
THE TOOL: A striking die for stamping gold-filled spectacle temples.

THE PROBLEM: When made from a straight carbon tool steel, the die would break after about 14,000 pieces.

THE SOLUTION: The Tool Engineer saw that *greater toughness* was needed, so he checked the *Matched Set Diagram* and found that *Solar* would probably give best results.

With *Solar,* output per tool jumped from 14,000 to 100,000 pieces!

2



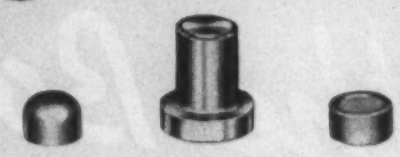
THE TOOL: A draw die for drawing bearing retainers from plain hot rolled steel 1/8" thick.

THE PROBLEM: After about 4,000 pieces, the die had to be replaced because of oversize wear. Replacing the worn die consumed 1 hour, during which the press was idle.

THE SOLUTION: Going to the top of the *Matched Set Diagram* for *greater wear resistance,* they selected *K-W* tool steel and got these results:

1. Tool life increased from 4,000 to 86,000 pieces.
2. Press shut-down time was reduced by 42 hours a month, which meant 52,500 pieces *extra output* per month.

3



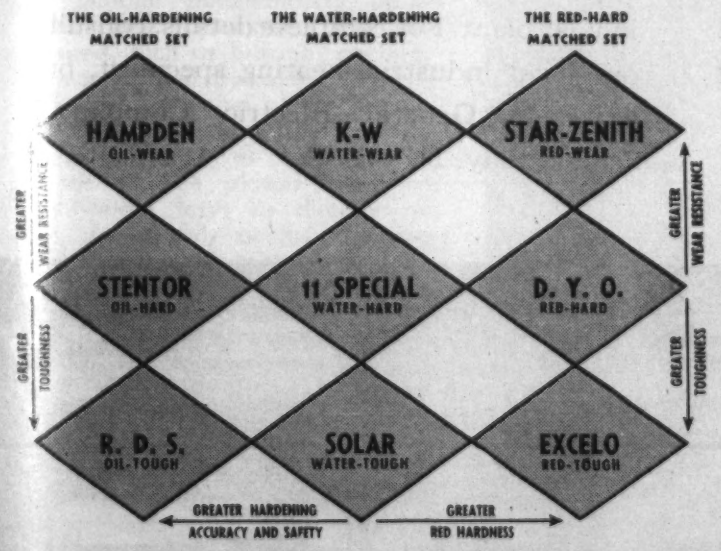
THE TOOL: A coining punch for forming bearing races from 1015 steel. Production speed of 16,000 pieces per day.

THE PROBLEM: Again and again, tools would fail after running only a half-day.

THE SOLUTION: Needing greater toughness, they selected *Solar* and got these results:

1. Tool life increased from 8,000 to 200,000 pieces, and the tool room had 48 fewer tools to make each month.
2. Output was stepped up 11,160 pieces per month.

How the Carpenter Matched Set Method Works



These nine steels will solve practically any problem that can come up in your tool room. They are called "Matched Tool Steels" because each one picks up its job where the other "leaves off".

The key steel is the one in the center—*No. 11 Special,* a straight carbon, tough timbre, water-hardening tool steel. When you have a tool to make, you ask yourself if it can be made from *No. 11 Special.* If the answer is "Yes", you go no further. But when the answer is "No", you use the diagram to point the way to the tool steel properties you need for the job.

For *greater wear resistance* you go north. For *greater hardening accuracy and safety,* you go east, etc. Thus, the Matched Set Method simplifies your tool steel selection problems.

Send for your copy of the "Carpenter Matched Tool Steel Manual" shown on the opposite page. It will tell you the whole story about the Matched Set Method, and will give you simplified heat treating instructions that will help you get better results.

Carpenter MATCHED TOOL STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

IS HEAT-TREATING *the Bottleneck* in Your Mass-production Schedule?

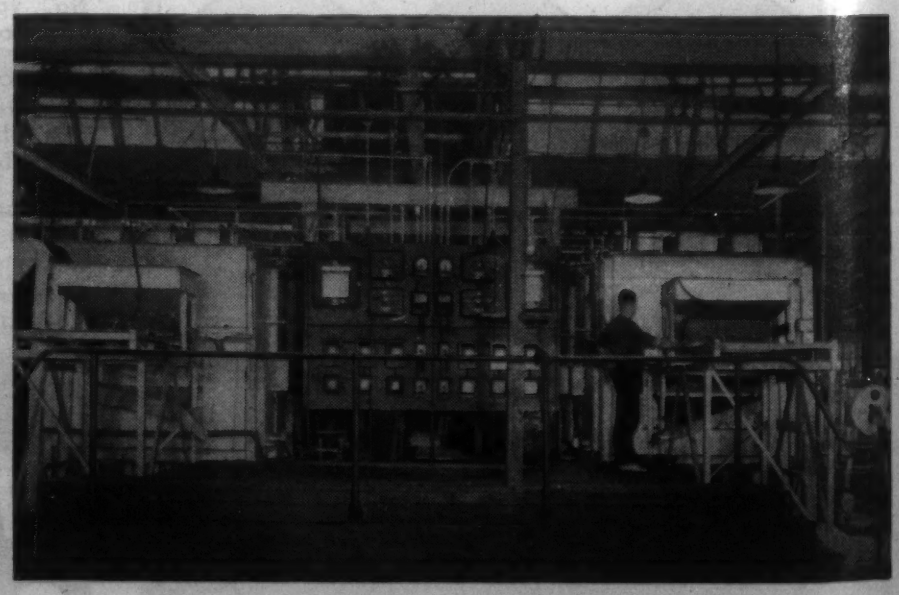
For fast, accurate heat-treating of mass-production parts you can't beat a continuous-type furnace

With any of these G-E furnaces you can put all the parts to be heat-treated through the same time cycle, the same temperature, and the same atmosphere—in *one* continuous operation. Every part receives *exactly* the same treatment; therefore, absolute uniformity is assured at all times. All four furnaces can be used with or without protective atmosphere to prevent oxidation and decarburization.

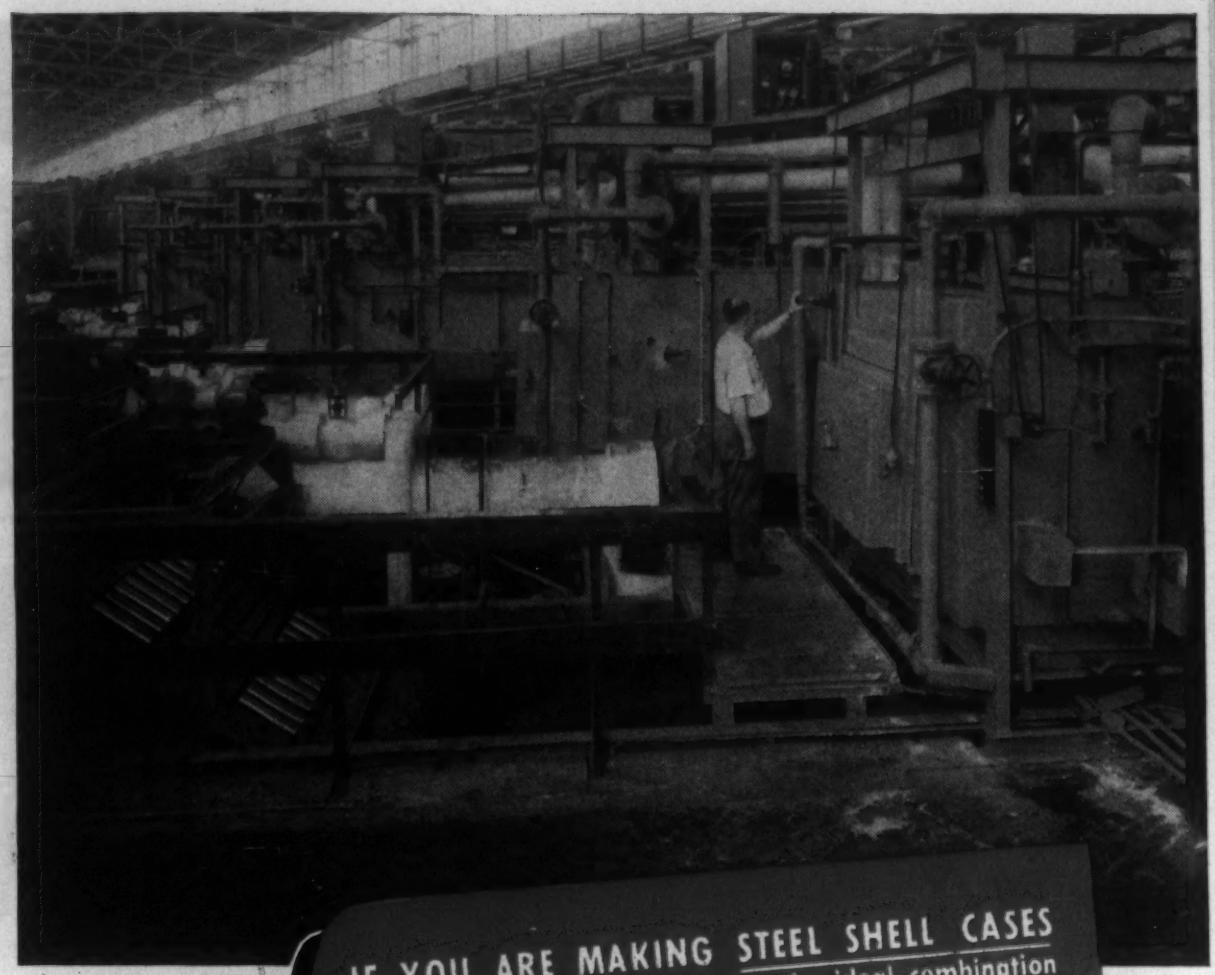
Production is unusually fast, because these furnaces are almost completely automatic—handling is reduced to the minimum.

It will pay you to investigate the possibility of using a continuous-type furnace in your plant. For complete details, consult our local industrial-heating specialist, or write to General Electric Company, Schenectady, New York.

The rotary-hearth furnace—particularly suited for heating parts that must be individually handled, such as gears, shells and cylinders. For normalizing, drawing, or scale-free hardening without decarburization. Charging and discharging are accomplished at the same location, simplifying the handling of the parts being treated.



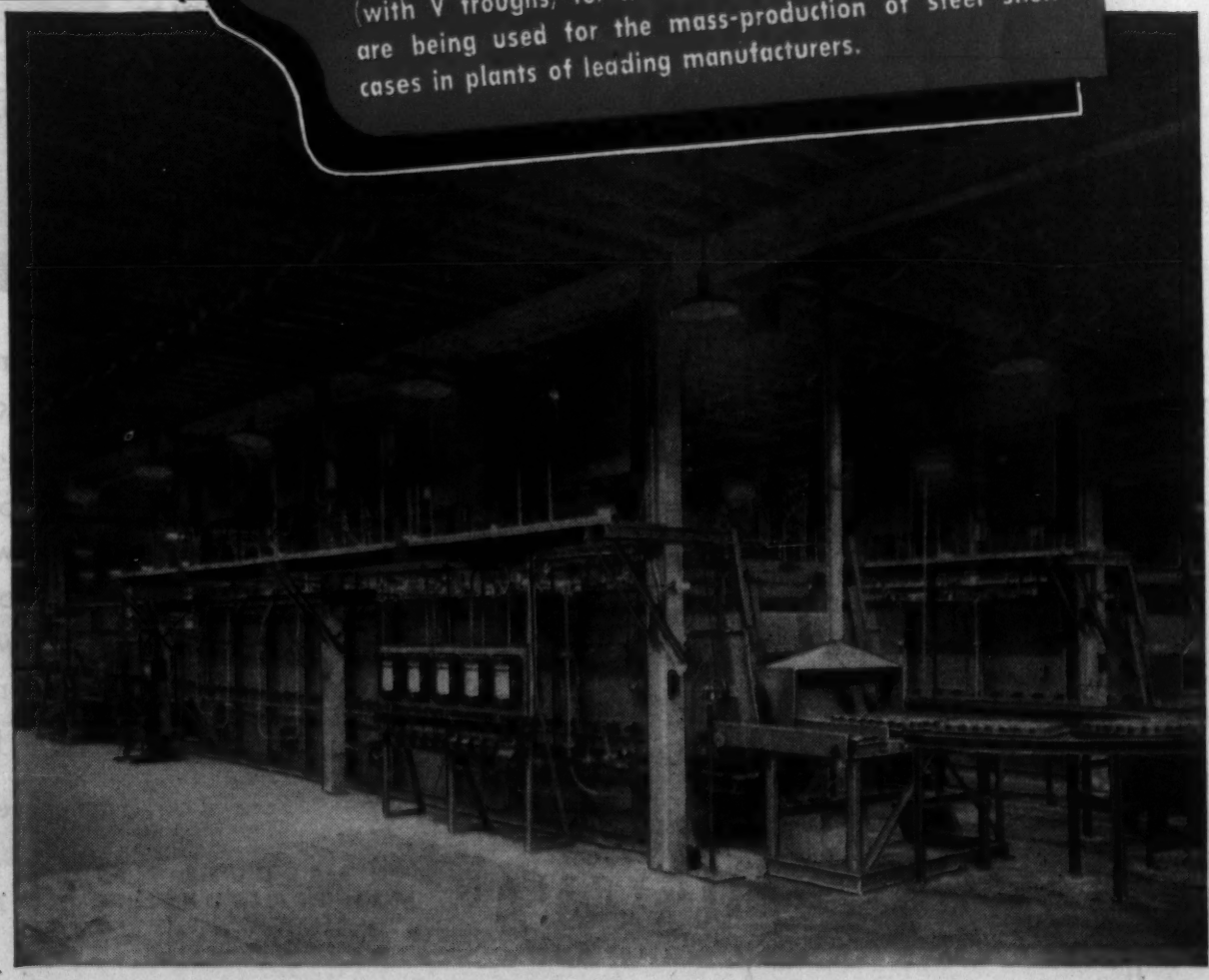
The belt-conveyor furnace—used for the accurate, automatic, scale-free hardening of bolts, machine-gun links, bearing races, tools, and many similar small steel parts. No trays are needed. Parts are simply loaded on the belt, which travels at a constant, set speed.



The pusher furnace, with V troughs—highly recommended for heating parts in protective atmosphere for hardening and drawing. Typical applications include shell cases, cylinders, round pins, and similar parts which can be pushed against each other and guided through the furnace by troughs.

IF YOU ARE MAKING STEEL SHELL CASES

you will find these two furnaces the ideal combination for fast, accurate heat-treating: the roller-hearth furnace for annealing after drawing, and the pusher furnace (with V troughs) for hardening. Both of these furnaces are being used for the mass-production of steel shell cases in plants of leading manufacturers.



The roller-hearth furnace—the most popular continuous-type furnace for all-round purposes. Used for brazing, annealing, normalizing, malleableizing, hardening, and sintering. Can be made to perform automatically practically any combination of cycles desired, such as brazing, cooling, reheating, and automatic quenching for hardening. Will handle either light or heavy parts in large quantities and at high speed. Work can be placed either on lightweight trays or directly on the driven rolls at the charging door. Automatic controls carry the charge through the furnace and discharge it without attention.

ELECTRIC FURNACES

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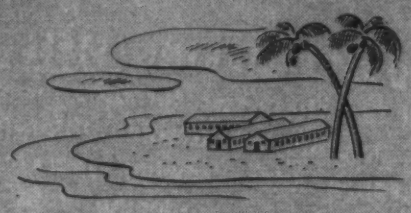
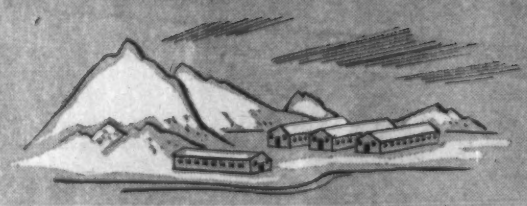


ANYWHERE



Picture of a hospital going somewhere.

OFFICIAL U. S. NAVY PHOTO

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Above . . .
Here it is, set up and operating . . . where it's needed.

•

An entire hospital unit of steel fabricated buildings . . . overseas.

OFFICIAL U. S. NAVY PHOTO

Are you making steel fabricated task force building assemblies? If so, let us help you with your painting problems. We know your specification requirements.

Egyptian Finishes are giving complete satisfaction on hundreds of such buildings now in service on all the far flung fighting fronts of the world.

Egyptian Finish, for steel fabricated task force buildings, can be applied by dip, spray or roller coating method. It dries quickly for handling and packing with a minimum of special equipment.

This is but one of the many finishing problems with which we can help you. Today, Egyptian service to you is definitely two way: 1—it covers the war products you are now making; 2—it covers the peace products you'll be making in the post war period to come.

★ ★ ★

Special correspondence on finishing problems is invited.

THE EGYPTIAN LACQUER MANUFACTURING COMPANY

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Egyptian's new U. S. Government "Spec" Book—4th Edition—is ready. It's helpful and it's FREE. Send for your copy. Please address Dept. I-12

EGYPTIAN FINISHES

EGYPTIAN

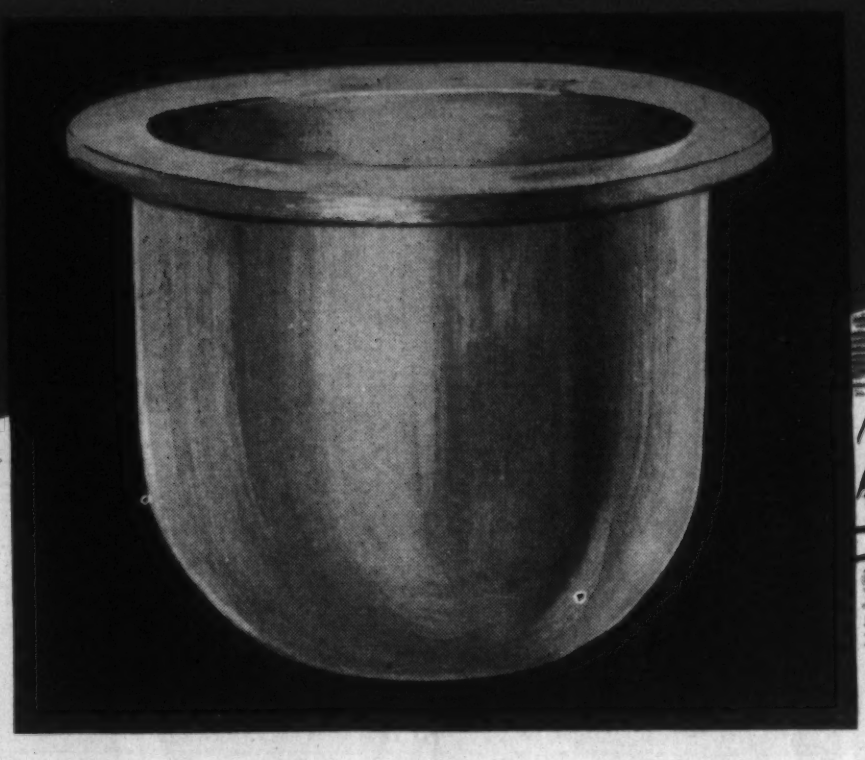
SUPERIOR FINISHES

"SWESCO"—The Melting Pot of the Magnesium Industry!

★ ★

PRODUCED BY MASS PRODUCTION IN WEIGHTS FROM 50 to 7500 POUNDS

• Any Size Or Design



WE were well prepared for the coming of the Light Metal Age! For 32 years manufacturers of cast steel melting pots and steel and alloy castings, it was natural for the new Magnesium Industry to look to us for aid in solving many of its problems. "SWESCO" Cast Steel Melting Pots were specially designed for the Magnesium Industry in size, design, chemical and physical analyses. They have also proved highly satisfactory for cyanide, lead and salt baths. Today, "SWESCO" Cast Steel Melting Pots are being used by leading magnesium smelters, die casters, foundries and incendiary bomb manufacturers. For more detailed information phone, write or wire Dept. SCS-5834 today.

GUN MOUNT PEDESTAL

TANK HUB

★

We're Helping To Smash The Axis— Thru Mass Production of Steel And Alloy Castings From ½ to 7500 Lbs.

It is our "know-how", born of more than a quarter of a century of experience, that is making a vital contribution towards the speedy defeat of the Axis! The Gun Mount Pedestal and Tank Hub illustrated here are but a few of the many important contributions that we are making for Victory!

• SERVING INDUSTRY FOR MORE THAN THIRTY-TWO YEARS

Swedish CRUCIBLE STEEL COMPANY

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"To serve you better"

This group of modernly-equipped plants comprises a unit devoted exclusively to the production of Aluminum Alloys to care for the ever-mounting demand for these versatile and important Alloys.

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ALUMINUM REFINERS

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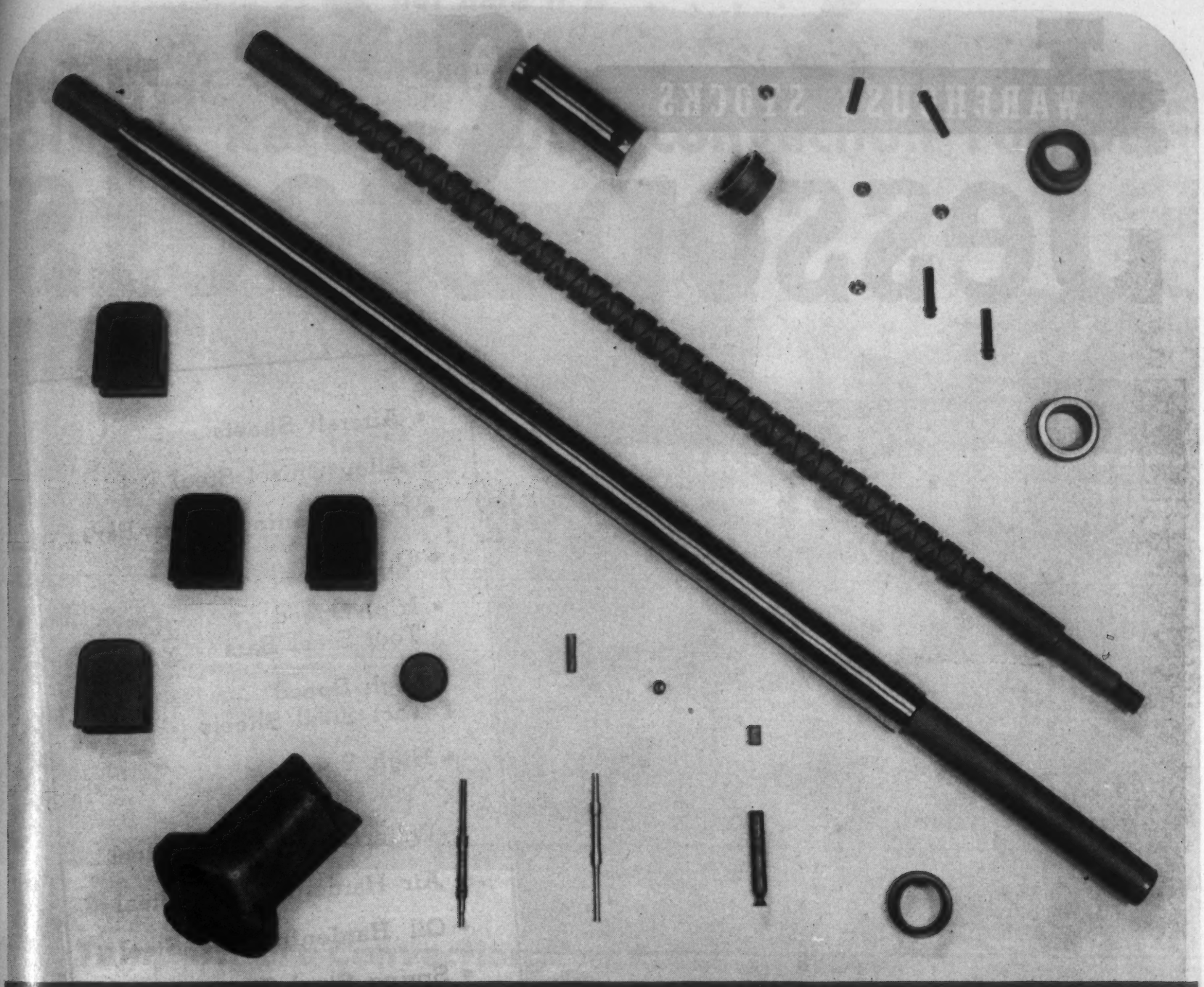
MANUFACTURERS OF ALL TYPES AND SHAPES OF CASTING AND DEOXIDIZING ALLOYS



Stainless Steel Parts

SURFACE HARDENED BY THE DREVER PROCESS

CASE DEPTHS:

Straight Chromium Grades: .010"
Types 410, 416, 430, etc.

Chromium-Nickel Grades: .005"
Types 302, 303, 316, 347, etc.

Heavier case depths if required.

HOT HARDNESS TEST:

Brinell Hardness No.	70°	1000°
Drever Surface Hardened	1050	710

Write today for Bulletin 21 giving details of the new uses to which you may now put Stainless Steels with Surface Hardening by Drever.

THE DREVER CO.

750 E. VENANGO STREET, PHILADELPHIA 34, PENNSYLVANIA

WAREHOUSE STOCKS

Jessop Steels

- Aircraft Sheets
- Alloy Chisel Steel
- Oil Hardening Hollow Bars
- Drill Rod
- High Speed Tool Steel Bars
- High Speed Tool Steel Sheets
- High Speed Tool Steel Bits
- Water Hardening Tool Steel
- Air Hardening Die Steel
- Oil Hardening Die Steel
- Spring Steel Sheets
- Music Wire
- Carbide Tip Tools

Jessop Electric Furnace Specialty Steels in various grades, sizes, and shapes are available for immediate delivery from warehouse stocks to service the needs of essential industries. In addition to the every-day demand for small lots of specialty steels, emergency orders make it especially important to have a source of the correct steel ready to meet such requirements. Jessop Warehouses are located in the principal production centers, and are staffed by experienced steel men. Contact the nearest Jessop Warehouse when you need alloy specialty steels in a hurry.

ARMY E NAVY

JESSOP STEEL CO. FINE JESSOP STEELS WASHINGTON, PA.

Established 1901

JESSOP STEEL COMPANY

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WASHINGTON, PENNA.

WAREHOUSES:
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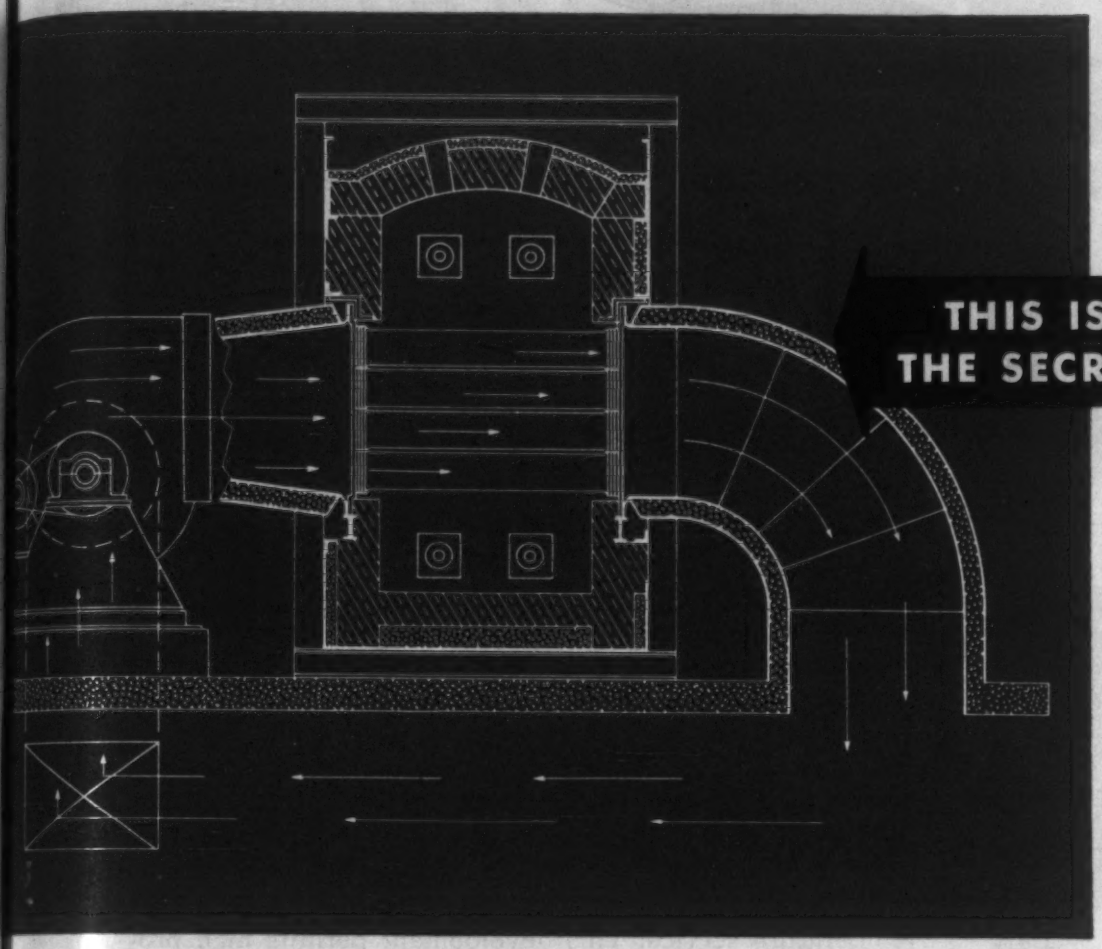
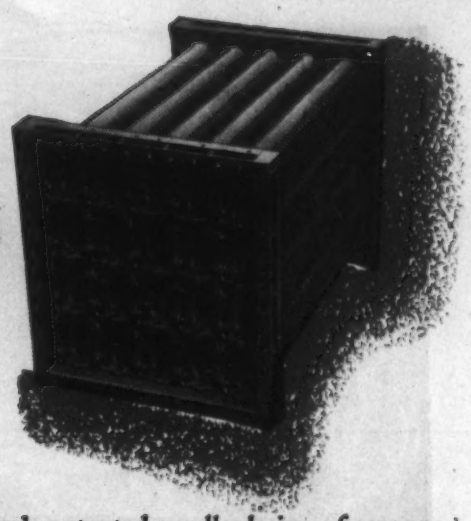
Impossible we were told but here it is . . . .

Salem's Recuperatube Convection Furnace





Salem's patented needle design of recuperatube makes this furnace performance possible by providing maximum transfer of heat from waste gases to air with a minimum of back pressure, and the most favorable degree of turbulence in air and waste gas streams.

High Temperature Convection Heating with Protected Atmosphere

THIS IS A REVOLUTION in convection heating because it includes all of the advantages . . . speed, uniformity, and low fuel consumption . . . yet eliminates the chief disadvantage—the products of combustion coming in contact with the material.

It represents another example of engineering ingenuity applied by Salem.

Atmosphere is heated by special Salem equipment located on top of the furnace. After circulating through the furnace, this atmosphere is returned to the heater. At no place inside the furnace can the temperature be any greater than the circulating atmosphere . . . hence, there cannot be any hot spots.

Due to the even distribution of temperature, the furnace walls and roof, as well as the materials which are being heat treated, take on such an even glow that you cannot distinguish one from the other. Since thin sections cannot become overheated, the furnace is particularly well adapted to heat treating either ferrous or non-ferrous products which have non-uniform sections.

Several of these furnaces have been installed and they are in operation. One was selected chiefly for the heating of shell cases, but it has operated so successfully that the firm is now using it for many other types of material.

This particular furnace, gas-fired, is operating up to 10,000 pounds per hour, net, at 1350°F.

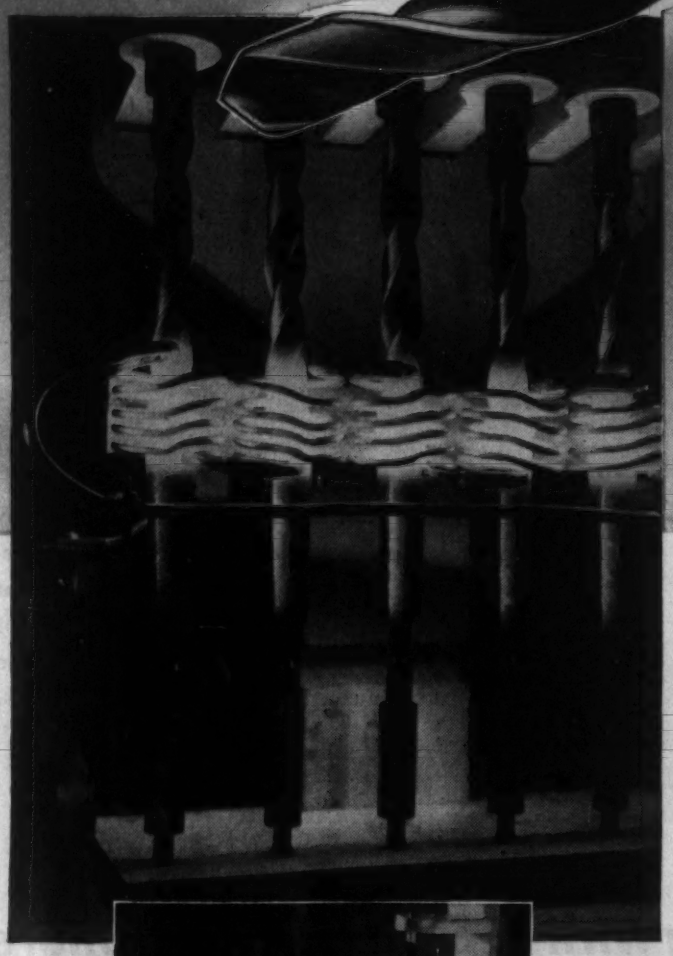
Salem can build a Recuperatube Convection Furnace to your specifications, with no size or fuel limitations. Information will be furnished promptly upon request.

SALEM ENGINEERING COMPANY

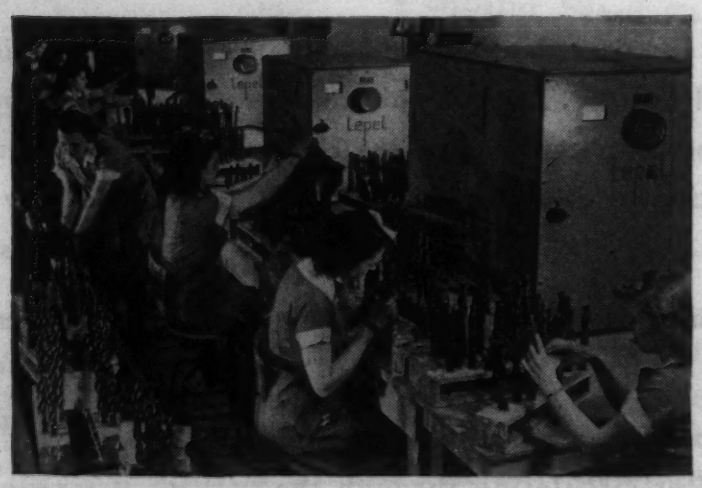
SALEM ENGINEERING CO. · SALEM, OHIO

New Republic Method

FOR MAKING TWIST DRILLS USING Lepel HIGH FREQUENCY INDUCTION HEATING



By replacing conventional welding methods with modern high frequency induction brazing, the Republic Drill & Tool Company, Chicago, Ill., have made an outstanding contribution to the efficient manufacture of twist drills. Photo at left shows the new Republic gang-brazing set-up for joining shanks and high speed drill barrels, on the larger size drills, by LEPEL induction heating. A special high temperature compound is used wherein the brazing action occurs at 1800° F., thus eliminating all danger of separation in high temperature service. This development permits high production machining of the shanks, and heat treatment of the fluted sections, *before* rather than after assembly. The advantages, the economy, the added efficiency . . . all are obvious.



Photos to left show gang-brazing department at Republic, with battery of compact, efficient LEPEL induction heating units; also, female operator quickly brazing a shank to one of the 'long ones' at Republic.

Whether your production problem involves BRAZING, SOLDERING, LOCALIZED HARDENING, ANNEALING, BOMBARDING or MELTING, LEPEL High Frequency Induction Heating in all probability can *greatly expand your output—reduce rejects to a negligible quantity—solve your skilled worker problem*—and *cut costs appreciably*. LEPEL Engineers will gladly and promptly submit facts and figures—based on your own work—if you will acquaint them with your problems. Write or wire today.

Lepel HIGH FREQUENCY LABORATORIES, INC.

39 West 60th Street, New York, N. Y.

PIONEERS IN INDUCTION HEATING

SMALL METAL TUBING is Our Only Business and We Know It . . .

(MAXIMUM O.D. 5/8" IN MANY METALS)

SUPERIOR

The big name in

SMALL TUBING

for Uncle Sam!

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

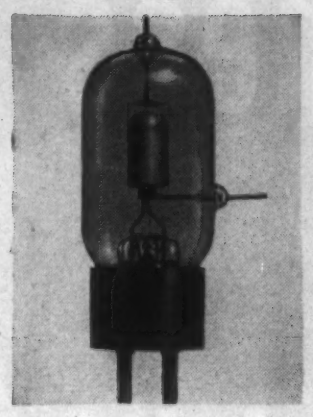
FOR EVERY SMALL TUBING APPLICATION

***Tubing from 5/8" OD down*...SUPERIOR** Seamless in various analyses. **WELDRAWN** Welded and drawn Stainless.

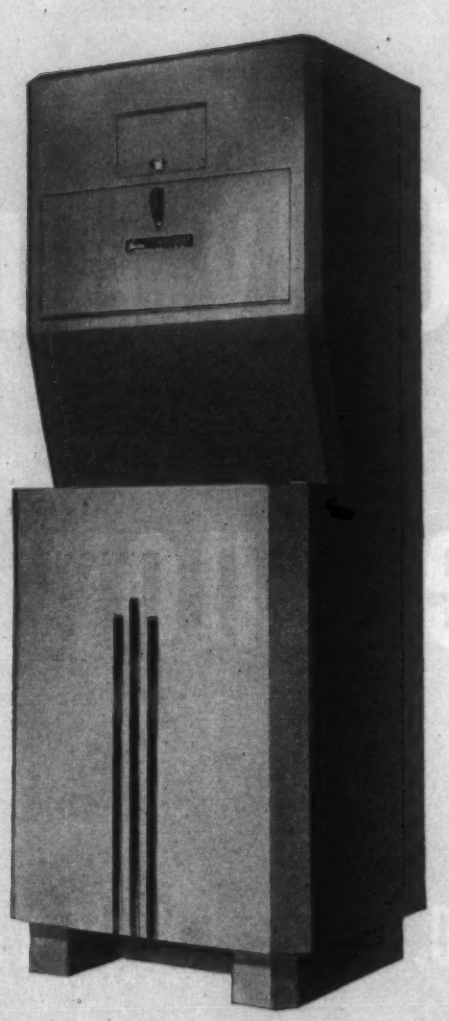
BRAWN Welded and drawn "Monel" and "Inconel". **SEAMLESS** and Patented **LOCKSEAM** Cathode Sleeves.

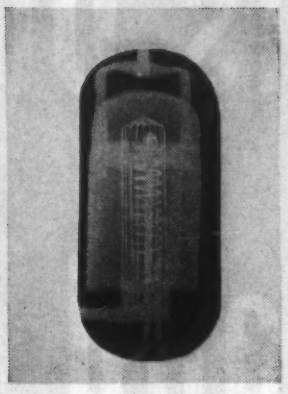
Norelco Searchray

Saves Manufacturing Trouble



Above is a photograph of a vacuum tube as the inspector's eye — and the camera — see it. A certain defect in manufacture is hidden to the eye. But Searchray, the new self-contained X-ray unit, shown in center, can spot it. See illustration at right.





Same tube as seen radiographically by Searchray. Note defect. The filament is too close to the grid, which will cause the tube to heat up. Searchray saves time, money and labor by checking products *before* assembly.

If you manufacture lamps, tubes, electrical parts, rubber, ceramics, light alloys or plastics—NORELCO Searchray can pay for itself many times over by acting as an X-ray inspection tool at every step of manufacture or assembly.

Shockproof, rayproof, foolproof and readily mobile, Searchray, the self-contained X-ray unit, is so simply devised that anyone can operate it safely. It examines objects both fluoroscopically and radiographically; it is as useful in the laboratory as on the assembly or production line.

The Searchray Model 80, illustrated above, is an 80 KvP, 5MA unit which operates on 110 volt A.C. simply by plugging into an outlet. Another Searchray — Model 150, likewise a self-contained, rayproof, shockproof, X-ray unit for fluoroscopic and radiographic examination, permits use of any kilovoltage up to 150 KvP, 10MA. It operates on 220 volts A.C.

Searchray may be of help in *your* product inspection problems. Write today to North American Philips. Let us tell you more about Searchray — and other NORELCO products.

For our Armed Forces we make Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes for land, sea and air-borne communications equipment.

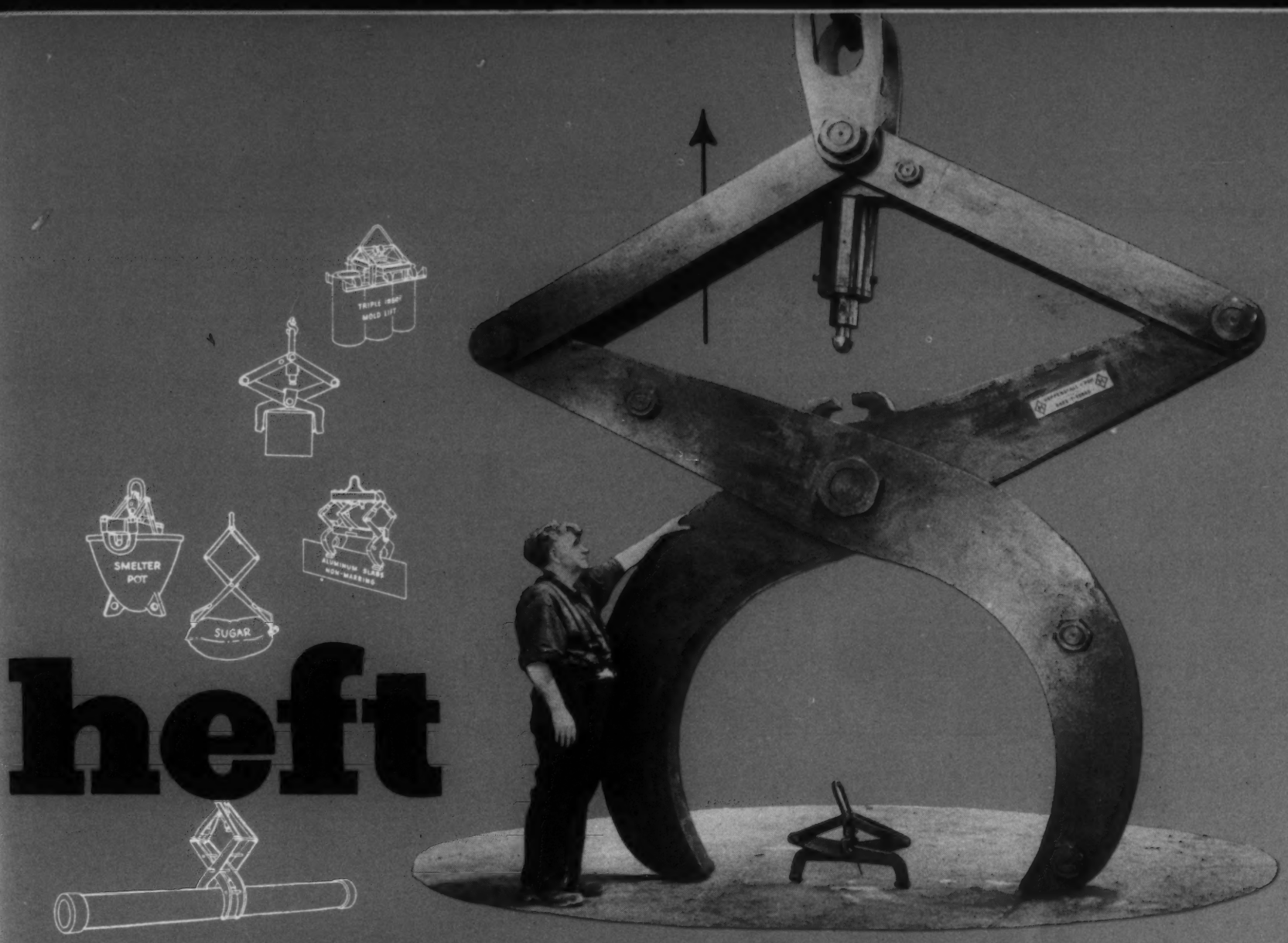
For our war industries we make Searchray (X-ray) apparatus for industrial and research applications; X-ray Diffraction Apparatus; Electronic Temperature Indicators; Direct Reading Frequency Meters; Tungsten and Molybdenum in powder, rod, wire and sheet form; Tungsten Alloys; Fine wire of practically all drawable metals and alloys: bare, plated and enameled; Diamond Dies; High Frequency Heating Equipment.

And for Victory we say: Buy More War Bonds.

Norelco ELECTRONIC PRODUCTS

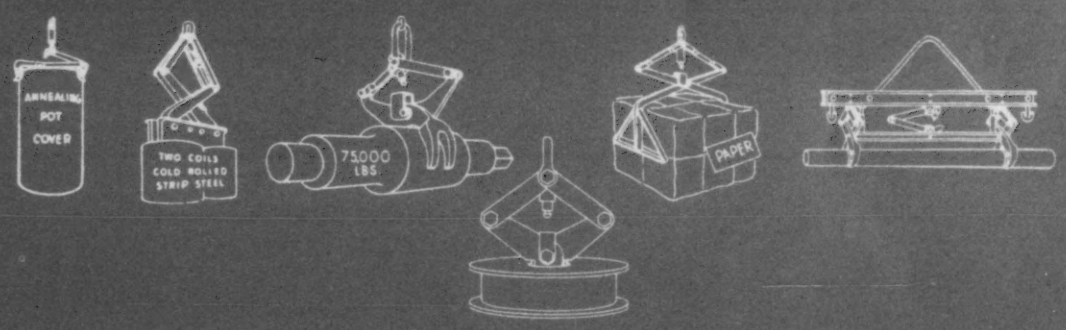
NORTH AMERICAN PHILIPS COMPANY, INC., 100 EAST 42ND STREET • NEW YORK 17, N. Y.

Factories in Dobbs Ferry, N.Y.; Mount Vernon, New York (Philips Metalix Corporation); Lewiston, Maine (Elmet Division)
Represented in Canada by Electrical Trading Company, Ltd., Sun Life Building, Montreal, Canada



heft

for any materials handling job!



Regardless of the weight, size or type of load, Heppenstall Safe-T Tongs will replace chains, slings or hooks and handle the load faster, safer and more economically . . . Heppenstall tongs are fully automatic—not power driven—no close work by ground crews needed. They are all specially designed for each specific job and are solving new problems in materials handling every day. Write for our new booklet that tells the complete story—you may get an idea from it that will save your plant considerable time, trouble—and money...Dept. H , Heppenstall Company, Pittsburgh, Pa.

Heppenstall Automatic Safe-T-Tongs

The Spark that Lights the Flame of Victory

A pinpoint of fighting metal placed in the arc of the spectograph writes its own signature on a photographic plate. Inside the instrument, the light from that flame is broken up by a prism as a prism breaks up sunlight. Each element identifies itself by a series of characteristic lines, always the same for the same basic element. It reveals to the spectrographer each constituent, what impurities are present and in what quantities.

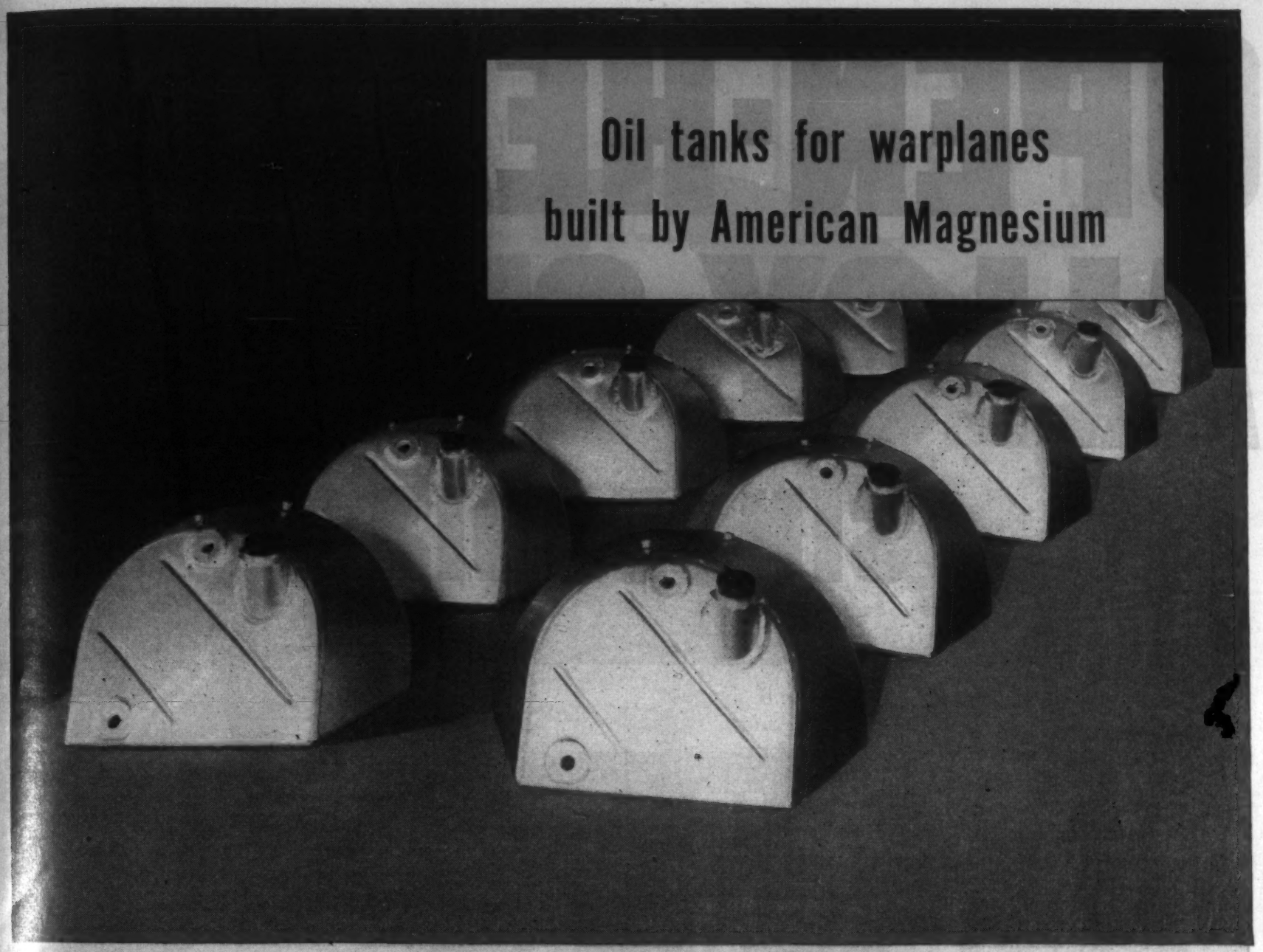
Thus spectrography helps in controlling inspection. It keeps tough fighting steels tough, helps in development of new fighting metals. Spectrography is used too in other fields . . . chemicals, foodstuffs, vitamins. It speeds research, control, and analysis. Today, spectrography is helping to build the tools of Victory as in peacetime it helps to make better cars and better breakfast foods.

Because Bausch & Lomb had long experience with such precision optical equipment needed in education, research, and industry, it was ready for quantity production of precision optical instruments of war such as gunfire control instruments, binoculars, and aerial photographic lenses. When the la gun is fired, Bausch & Lomb will devote i enlarged experience to peacetime optic production. Through war and peace, Baus & Lomb has continued . . . and will contin . . . to do the job it knows how to do be *Here again optical science is seeing it throug*

For Bausch & Lomb Instruments essential t Victory—priorities govern delivery schedule

BAUSCH & LOMB
OPTICAL CO. • ROCHESTER, N. Y.
ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTI



Very light in weight, because they're made of magnesium, these tanks help increase a plane's "payload" capacity. Built, accurately, on a production basis for use on an airplane assembly line, schedules are high, while costs are held down. In service, these tanks preserve the quality of the oil they carry, for magnesium does not attack, nor is it attacked by, the oil.

Do these properties of a wartime magnesium product suggest ways of improving what you will manufacture in peacetime?

American Magnesium's facilities, which made possible a quick change-over to this kind of production when the emergency first arose, will be available to you for that peacetime production. The knowledge of design and skill in manufacturing gained in more than twenty years of working with magnesium will be yours for the asking. Our engineers will be glad to advise you on how best to employ this lightest of the lightweight metals.

Send for a free copy of the new book, "Designing with Magnesium". American Magnesium Corporation, 1710 Gulf Building, Pittsburgh, Pennsylvania.

MAGNESIUM MAZLO PRODUCTS

REG. U.S. PAT. OFF.

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

OPEN-HEARTH ALLOY STEELS

SINCE 1912

ANDREWS STEEL

Thirty-one years' experience in melting and rolling a large range of analyses—in many combinations. The Andrews Steel Company enjoys a national reputation for unusually high quality and exceptional service. Try it!

THE ANDREWS STEEL CO.
NEWPORT, KENTUCKY

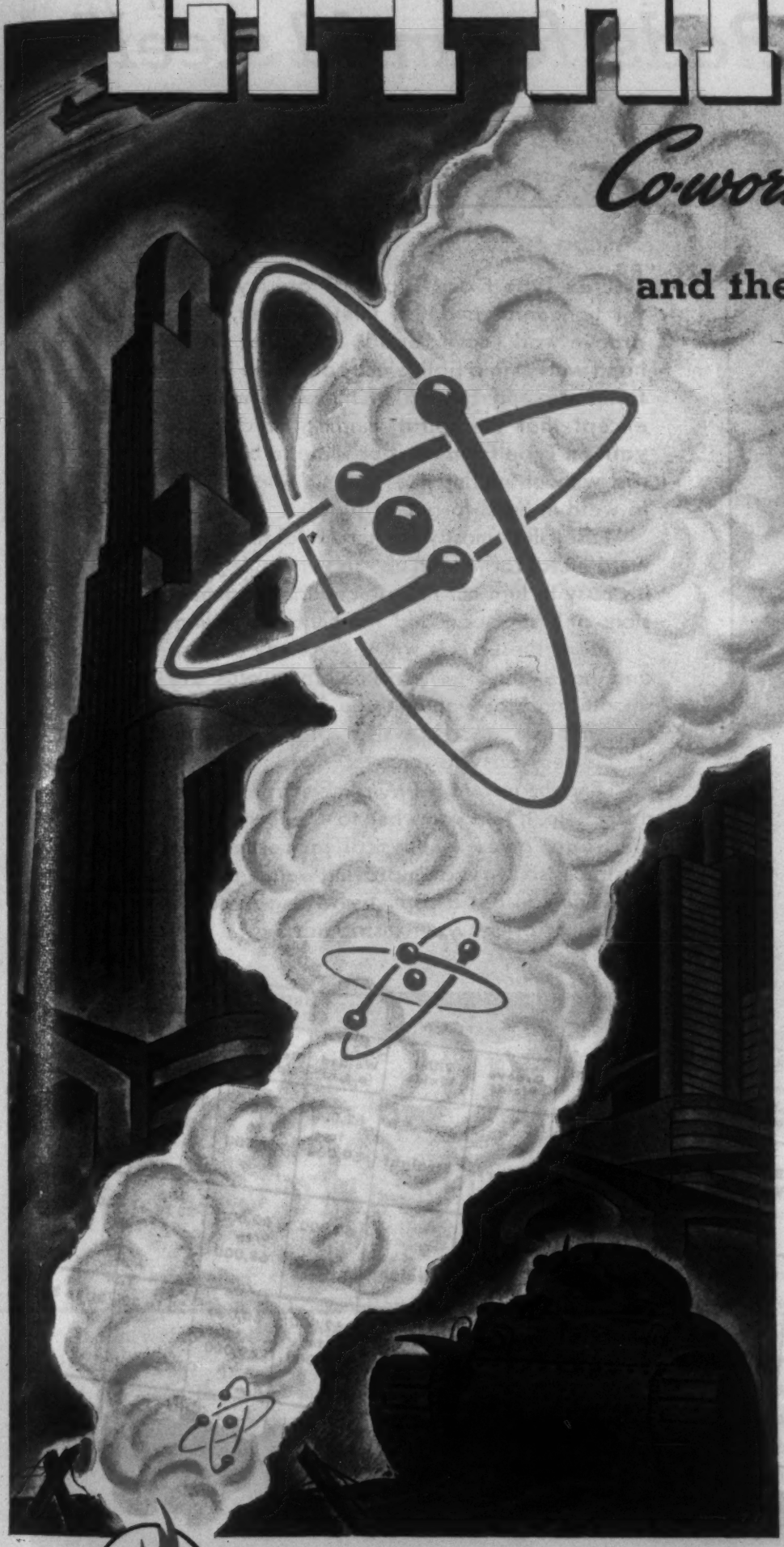
ANDREWS STEEL

Electric furnace alloy steel will be available from our electric furnace plant for late January melting and February delivery.

LITHIUM

Co-worker for Victory . . .

and the new World of Tomorrow



Under the spur of war, heat treating and carburizing—final processes in making fine steels—have been stepped years ahead by one invention alone . . . something so radical in its effect on production for war, that many who first saw it refused to believe even their own eyes . . . so startling were the results.

It all starts with LITHIUM, an element that is hungry for oxygen. LITHIUM kills oxygen—the worst enemy of heat treating. If not checked, oxygen—and its destructive companions, water vapor and carbon dioxide—will rapidly corrode fine steel and even rob it of its carbon.

In heat treating and carburizing furnaces, LITHIUM protects the steel by surrounding it with a metallic vapor which blots up every trace of oxygen and renders the furnace atmosphere entirely harmless to the metal. The magic vapor continues to surround the metal with a protective blanket until it leaves the furnace . . . unbelievably bright, unaltered in composition and strength, ready for assembling.

Many war plants use LITHIUM metallic vapor Atmosphere Furnaces to save time, manpower, materials . . . all definite contributions to Victory.

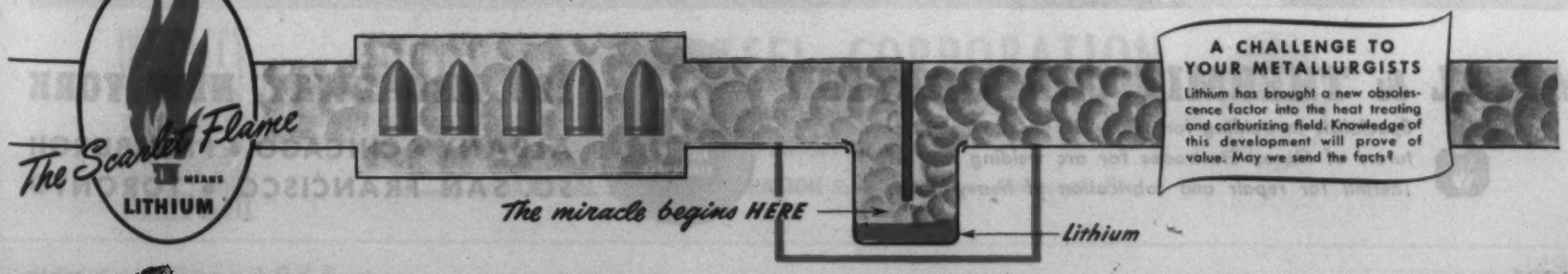
When peace comes, Lithium will aid you in winning that next victory . . . the one over competition.

The Lithium Company

Manufacturers of Lithium Atmosphere Furnaces

111 Sylvan Avenue, Newark, N. J.

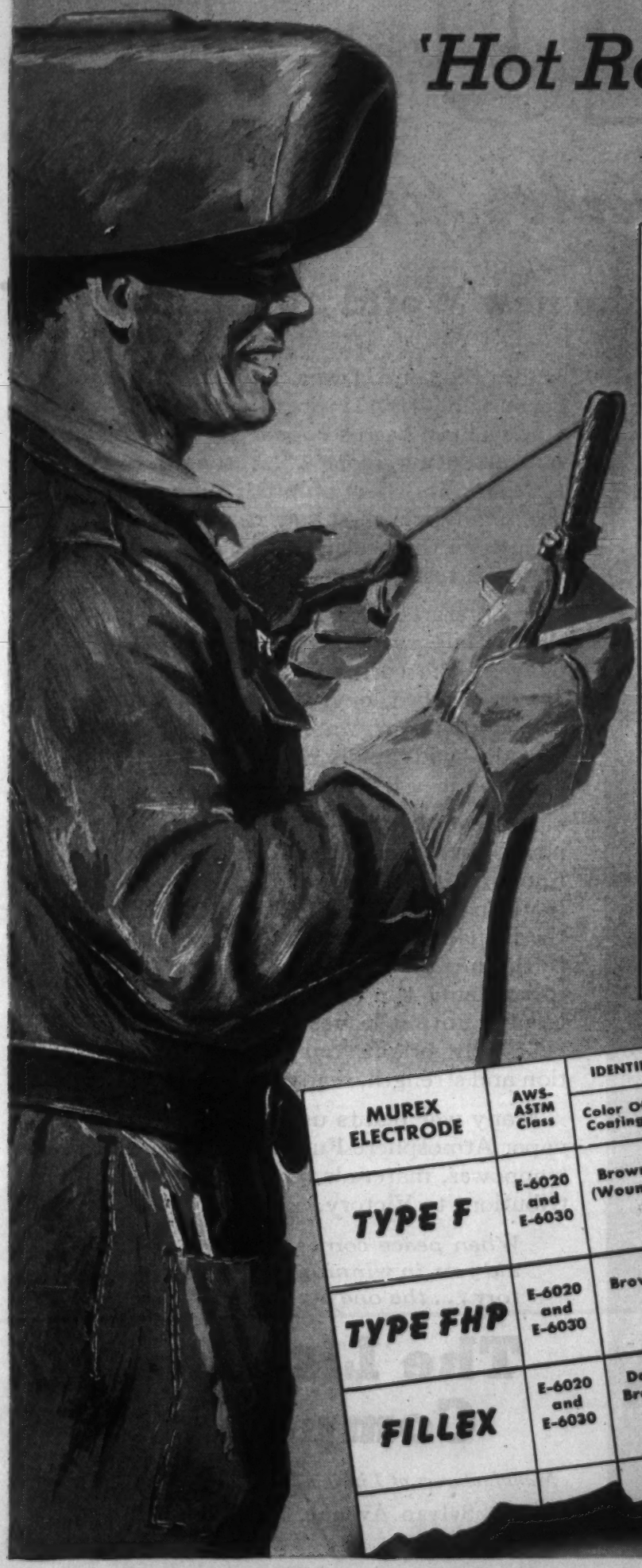
The Scarlet Flame means LITHIUM



A CHALLENGE TO YOUR METALLURGISTS

Lithium has brought a new obsolescence factor into the heat treating and carburizing field. Knowledge of this development will prove of value. May we send the facts?

"Let me tell you about these Murex 'Hot Rods' for mild steel"



"Murex Type F and Type FHP are my choice for horizontal and flat fillet welding, deep groove work, cover beads and other downhand work. I find both electrodes alike in performance and quality of the weld metal—except that the spiral winding of asbestos yarn on Type F makes it possible to bend the rod without injuring the coating when I have to weld in hard-to-get-at places.

"I use Fillex mostly for horizontal fillets. The weld metal forms well up the vertical leg and it's easy to turn out fillets of equal leg dimensions at high speed and without undercutting.

"All of these rods will take plenty of heat and have good penetration. The welds are smooth, and, as you can see from the table below, have good physical properties. The slag is very easy to remove.

"I find the new M & T Murex Electrode Chart a big help. It tells you when to use each Murex electrode, gives its physical properties and illustrates six ways of improving welding practice.. You can get a copy by writing Metal & Thermit or asking your distributor."

MUREX ELECTRODE	AWS-ASTM Class	IDENTIFICATION		Current	POLARITY		TENSILE STRENGTH OF DEPOSIT		ELONGATION OF DEPOSIT IN 2"	
		Color Of Coating	Color On Tip		Groove Welds	Fillet Welds	As Welded (p.s.i.)	Stress Relieved (p.s.i.)	As Welded %	Stress Relieved %
TYPE F	E-6020 and E-6030	Brown (Wound)	Blue	A. C. or D. C.	Reverse	Straight	62,000 to 69,000	60,000 to 67,000	25 to 31	30 to 36
TYPE FHP	E-6020 and E-6030	Brown	Blue	A. C. or D. C.	Reverse	Straight	62,000 to 69,000	60,000 to 68,000	25 to 31	30 to 36
FILLEX	E-6020 and E-6030	Dark Brown	Blue	A. C. or D. C.	Straight	Straight	62,000 to 70,000	60,000 to 69,000	25 to 30	30 to 33

METAL & THERMIT CORPORATION

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

MUREX ELECTRODES

120 BROADWAY, NEW YORK

ALBANY • CHICAGO • PITTSBURGH
SO. SAN FRANCISCO • TORONTO

That they may *breathe and live and fight*

OXYGEN TANKS OF
N-A-X 9115 ALLOY STEEL

Up in rarefied, sub-zero skies, the lives of aviators and air-borne wounded depend on the oxygen tank—an item in which steel requirements are especially severe and complex.

Here, the metal must be *tough* with tensile strength to withstand high operating pressures and take the impact of gun fire without shattering . . . yet weight restrictions necessitate the use of a comparatively light gauge sheet, and critical steel making alloys have to be conserved.

In addition to these specifications, the steel has to have the properties necessary for atomic hydrogen arc welding on fully automatic equipment.

This difficult and important problem has been solved successfully by Chambers Corporation of Shelbyville, Indiana. They spent over a year in development work, and they selected N-A-X 9115 Alloy Steel as their basic material . . . Write for our new book on N-A-X 9100 Series Steel. It may help you solve other vital problems.

DUCTILITY — IT'S INHERENTLY FINER GRAIN MAKES ALL THE DIFFERENCE — STRENGTH

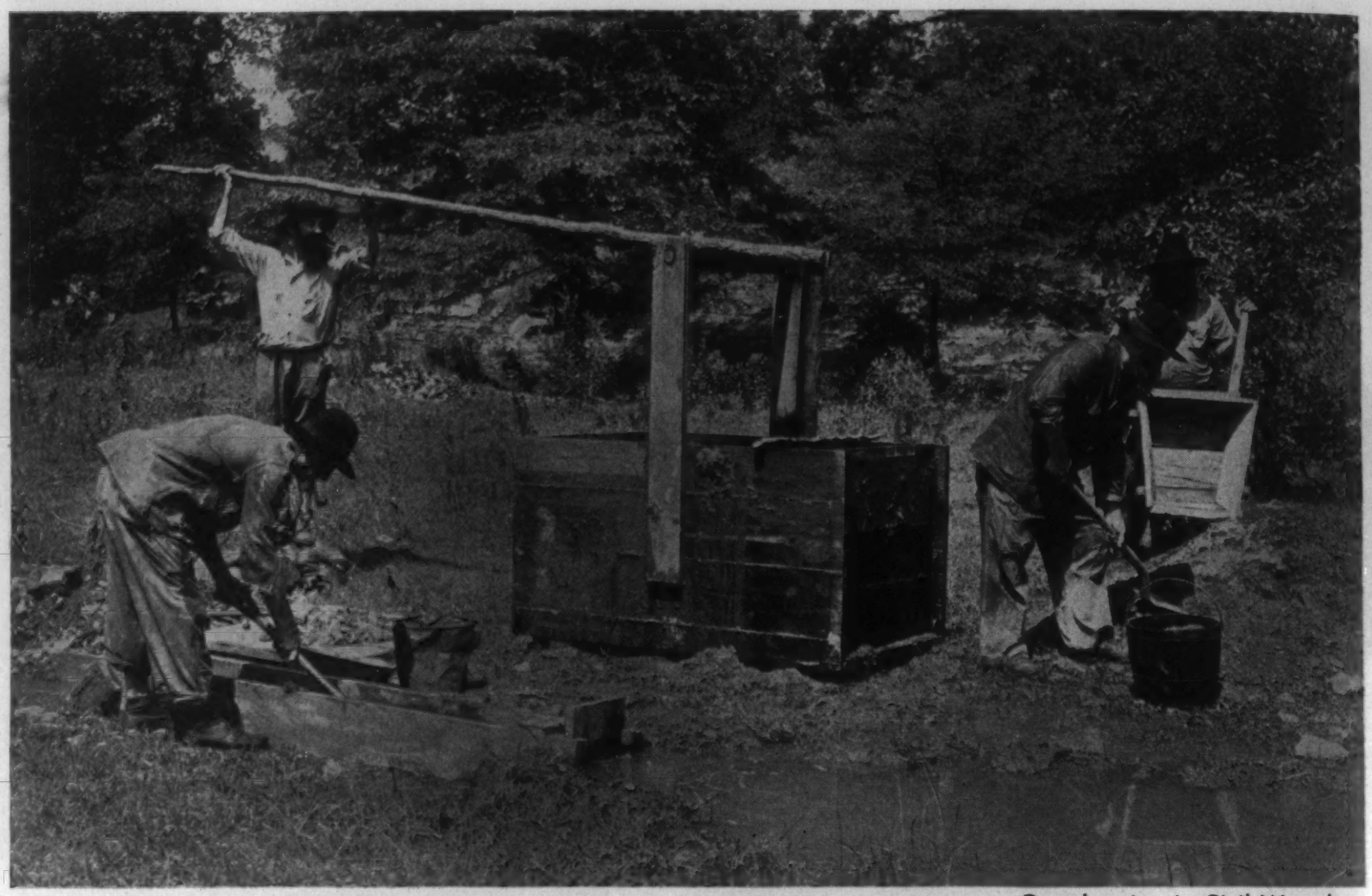
GREAT LAKES STEEL CORPORATION

DETROIT, MICHIGAN

Sales Offices in Principal Cities

Division of **NATIONAL STEEL CORPORATION** *Executive Offices, Pittsburgh, Pa.*

NATIONAL STEEL CORPORATION



Ore dressing in Civil War days

Bureau of Mines Photo

MANPOWER

The greatest problem confronting industry today is manpower. A year ago, even six months ago, the problem was material—in the non-ferrous metals field: aluminum, copper, zinc, lead, etc. In October, High Grade zinc was placed in Group II of Material Substitutions, indicating supplies "sufficient to meet war demands plus essential industrial demands under existing administrative control."

In order to produce the greatest quantity of war materiel today, parts must be manfactured with manpower economy; die-castings must be used instead of machined parts. England faced the manpower shortage long ago, and took up some of the slack by replacing machined parts and assemblies with die-castings.

Not only in war materiel but in the production of office machinery and other essential civilian products, engineers and designers should be considering the more extensive use of die-castings.

Follow the advice of the War Production Board as given in the Materials Substitutions and Supply List issued October 1, 1943: "Due to manpower shortages greater emphasis should be placed on the use of materials best suited to low unit labor processes such as stamping, die moulding and die casting, automatic screw machines, etc."

Die casting is the process—Zinc the material.

ST. JOSEPH LEAD COMPANY

250 PARK AVENUE • NEW YORK 17, • ELdorado 5-3200

Lead	*Zinc Oxide*	*Antimony*
Zinc	*Antimonial Lead*	*Cadmium*

THE LARGEST PRODUCER OF LEAD IN THE UNITED STATES

Follansbee for Steel

Sterling for Silver

What "Sterling" means to silver, the "Follansbee Smith" means to open hearth steel.

Ever since Madison was President, the Follansbee Steel Corporation and its predecessors have continuously enjoyed a reputation for quality. First it was as an importer of bar iron and tin plate, later as a steel producer. Products have changed. Methods have changed. But the policy of making products of the highest possible standard has remained constant.

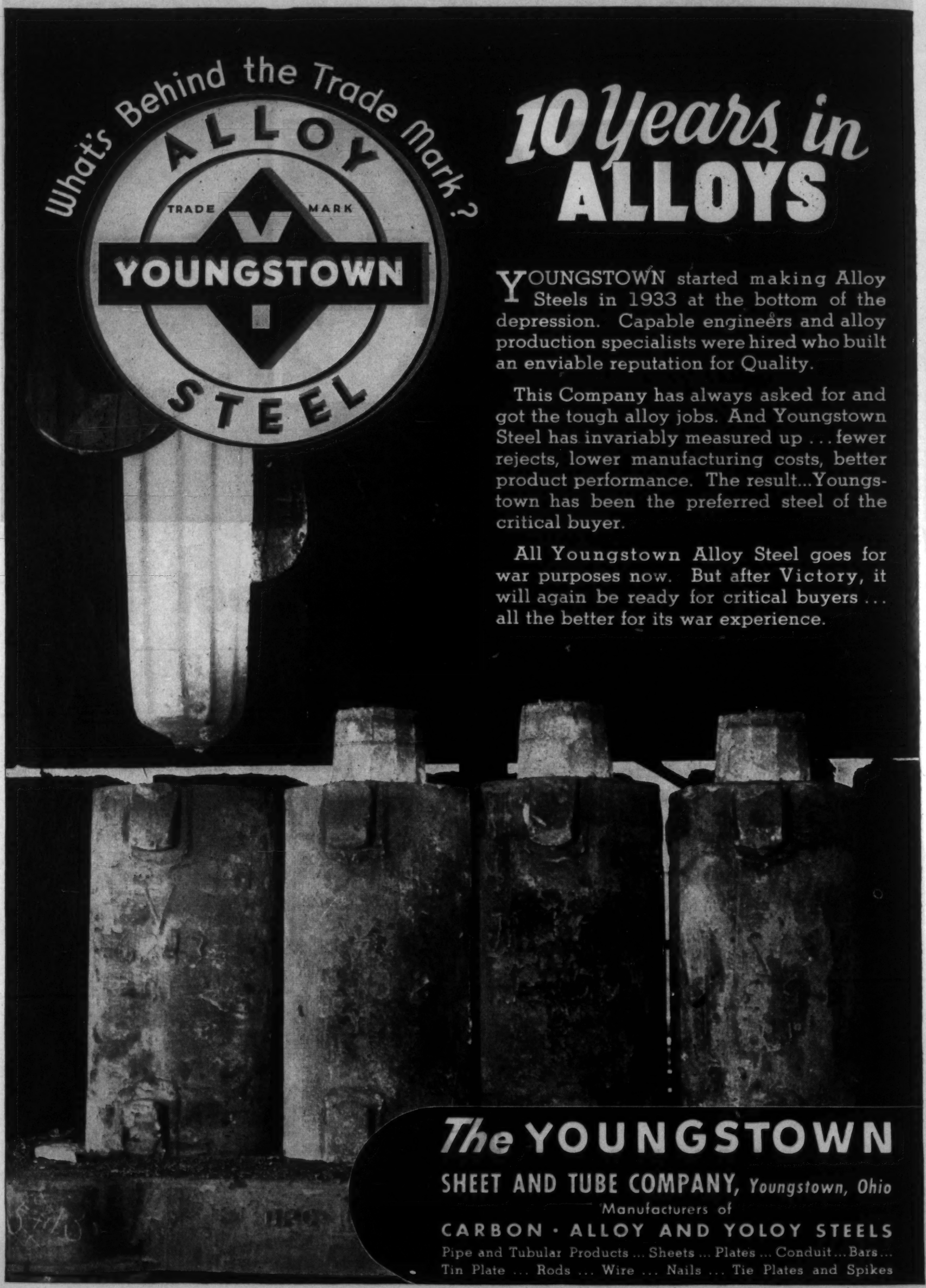
Today, Follansbee's compact, highly skilled organization is continuing that reputation by its ability to produce quality steel to meet the specialized requirements of its customers. Look for "Sterling" on silver . . . look for the "Follansbee Smith" on steel.

FOLLANSBEE STEEL CORPORATION

GENERAL OFFICES • PITTSBURGH 30, PA.

Sales Offices—New York, Rochester, Cleveland, Detroit, Milwaukee. *Sales Agents*—Chicago, St. Louis, Nashville, Los Angeles, Toronto and Montreal, Canada. *Plants*—Follansbee, W. Va. and Toronto, Ohio

ALLOY BLOOMS, BILLETS, BARS, SHEETS & STRIP
COLD ROLLED SHEETS & STRIP • POLISHED BLUE SHEETS • ELECTRICAL SHEETS & STRIP • SEAMLESS TERNE ROLL ROOFING



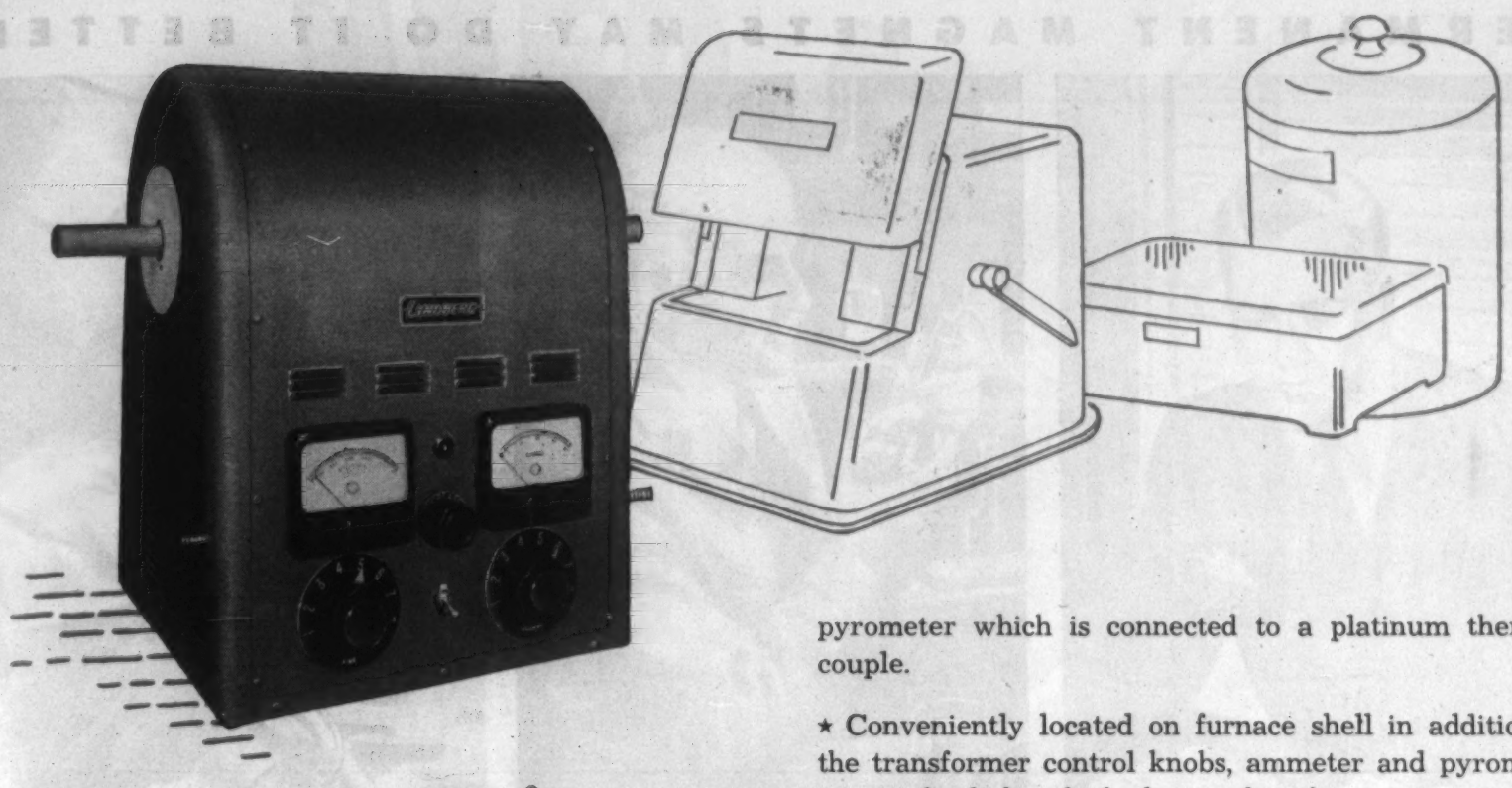
10 Years in ALLOYS

YOUNGSTOWN started making Alloy Steels in 1933 at the bottom of the depression. Capable engineers and alloy production specialists were hired who built an enviable reputation for Quality.

This Company has always asked for and got the tough alloy jobs. And Youngstown Steel has invariably measured up . . . fewer rejects, lower manufacturing costs, better product performance. The result...Youngstown has been the preferred steel of the critical buyer.

All Youngstown Alloy Steel goes for war purposes now. But after Victory, it will again be ready for critical buyers . . . all the better for its war experience.

The YOUNGSTOWN
SHEET AND TUBE COMPANY, *Youngstown, Ohio*
Manufacturers of
CARBON · ALLOY AND YOLOY STEELS
Pipe and Tubular Products ... Sheets ... Plates ... Conduit ... Bars ...
Tin Plate ... Rods ... Wire ... Nails ... Tie Plates and Spikes



Dependability

IN YOUR LABORATORY!

THE NEW LINDBERG LABORATORY FURNACES AND HOT PLATES are engineered for dependable performance and built for long life. In addition, they are designed to add to the high standard of present day laboratory cleanliness. Even the most fastidious technician will appreciate the modern streamlined appearance Lindberg equipment presents.

Pictured above is the Lindberg Combustion Tube Furnace. Let's glance over the many important features you can benefit by in your laboratory.

★ Because of the high temperatures obtainable, this furnace is ideal for fast modern volumetric methods of carbon or sulphur determination as well as gravimetric determination on carbon and all alloy steels, including stainless and heat resisting steels.

★ Three low voltage, high temperature Globar elements permit continuous operation with temperatures up to 2500°F. or for occasional operation to 2650°F. Heating elements are easily accessible—no inconvenient dismantling and assembling job required to replace them. Temperature is regulated by a built-in variable voltage transformer with coarse or fine adjustment for amperage control. Adjustment is made by merely making the necessary settings with the amperage control knobs.

★ An ammeter is provided to show the proper and safe current required for the Globar heating elements. The temperature in the combustion zone is indicated by a pyrometer which is connected to a platinum thermocouple.

★ Conveniently located on furnace shell in addition to the transformer control knobs, ammeter and pyrometer are a pilot light which shows when furnace is in operation; an on and off switch; and adjusting knob for controlling oxygen flow through a needle valve and rubber tubing adapters connected to the needle valve.

★ Furnace is equipped with adapters for easy interchangeability of tubes. Three sizes of tubes, 1", 1¼", and 1½" O.D. can be adpated, while fourth tube, 2" O.D., can be used without adapters.

★ For 60 cycle, AC current with voltage at either 110 or 220 volts. Furnaces for 25 cycle operation can also be supplied.

See your dealer today. He will be pleased to go over your requirements and point out the advantages you get with the new Lindberg Combustion Tube Furnaces, Box Furnaces, Crucible Furnaces and the new laboratory Hot Plates.

LINDBERG

Well-known Throughout the World as the Leaders in Developing and Manufacturing Industrial Heat Treating Equipment

ARMY E NAVY

LINDBERG ENGINEERING COMPANY
2450 WEST HUBBARD STREET, CHICAGO 12, ILLINOIS

SOLD EXCLUSIVELY THROUGH LABORATORY EQUIPMENT DEALERS

PERMANENT MAGNETS MAY DO IT BETTER

DESIGN

CONTROL

PRECISION

33 YEARS OF "KNOW-HOW"

. . . available to you!

WHILE age alone provides no claim for preferential consideration, our 33 years in this industry have given us exceptional experience in permanent magnet applications. This experience should prove invaluable to you in the solving of your engineering and development problems.

Permanent magnets are now being utilized in many applications not previously apparent. Units of our design and manufacture have increased the uses and improved the functions of countless products. Among those important to the war effort are some of this country's most vital electronic devices.

Our engineers will be pleased to consult with you and give your problems the benefit of their knowledge.

Write on your letterhead, for the address of our office nearest you—and our 30-page "Permanent Magnet Manual".

BUY AN EXTRA WAR BOND!

The
INDIANA STEEL PRODUCTS
Company

★ SPECIALISTS IN PERMANENT MAGNETS SINCE 1910 ★

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

NEED ANY HELP?

Ask RUSTLESS

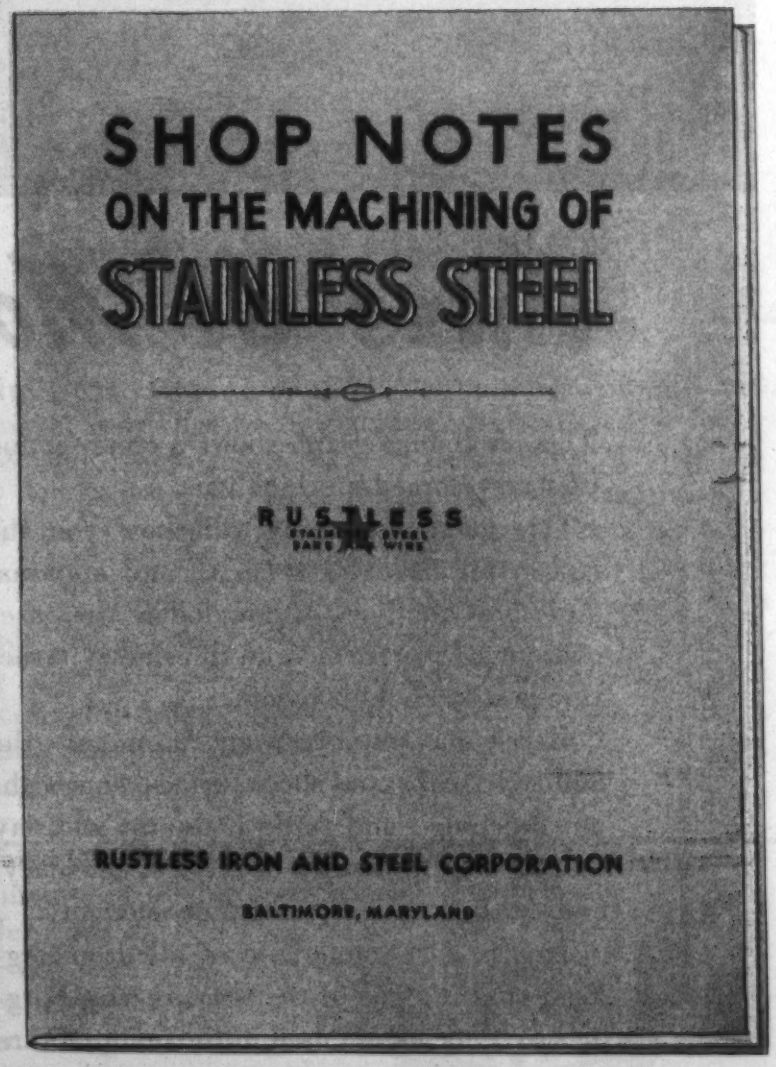
Every day, from all over America, Canada and other countries, we are receiving many similar requests for machining information.

Because of its widespread use in war equipment, Stainless Steel is being machined by thousands who never had experience with it prior to the war. Techniques of machining Stainless differ from those used with other steels and non-ferrous metals. Through constant research, Rustless has learned many ways to increase speeds of machining, improve production and finish.

Our booklet—SHOP NOTES On The Machining of Stainless Steel—is making a real contribution to the war effort, increasing efficiency in production and conserving vital time and material.

This booklet has proved so helpful that we are receiving hundreds of requests for additional copies. Write for your copy of SHOP NOTES today and it will be mailed immediately. If you have a specific problem, call our nearest District Office.

If It's Urgent, Ask RUSTLESS By Phone
Wolfe 8400, Baltimore, Maryland



Rustless
Producing STAINLESS STEEL Exclusively

RUSTLESS
IRON AND STEEL CORPORATION
BALTIMORE, MARYLAND

ARMY E NAVY
BUY WAR BONDS AND STAMPS

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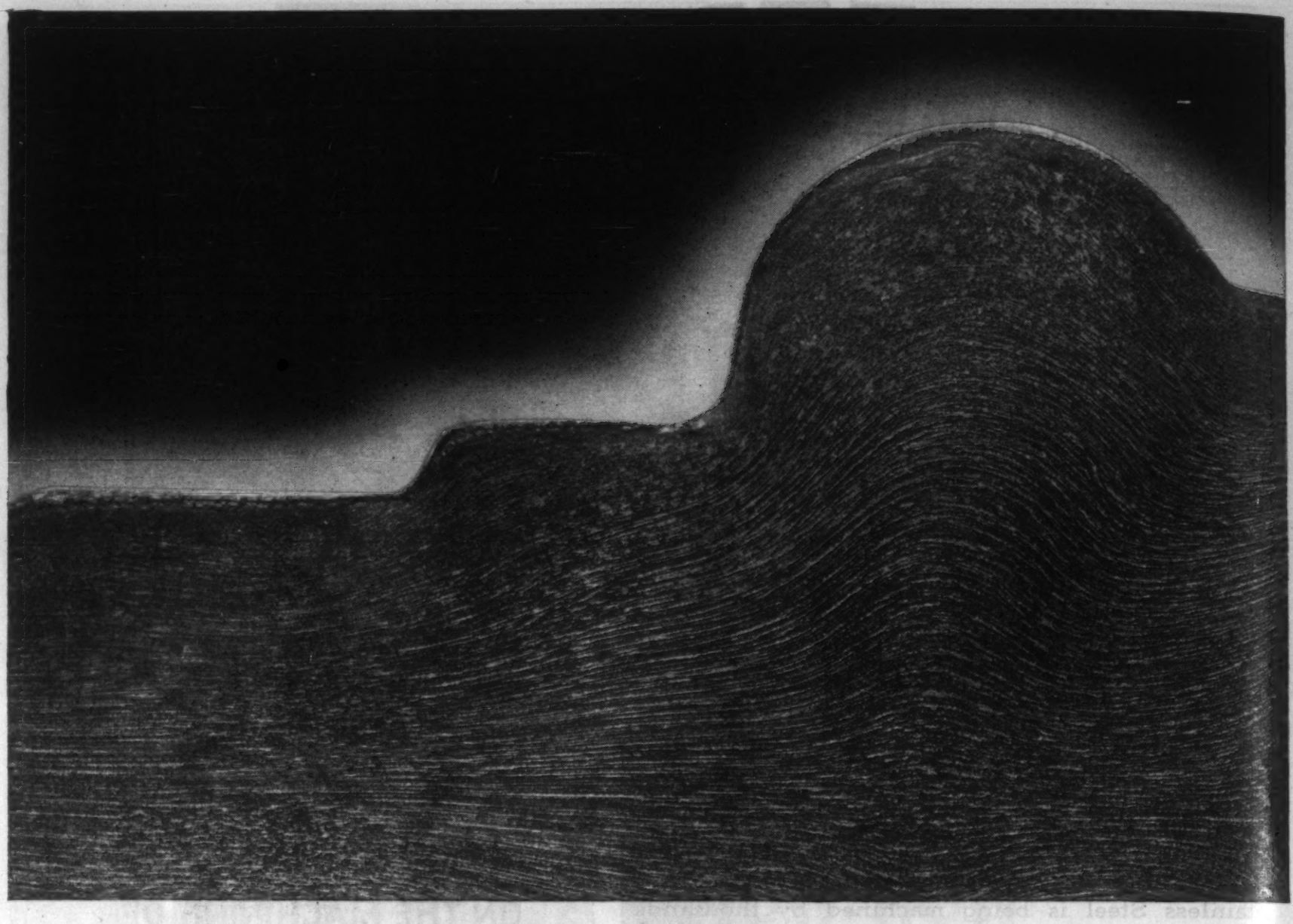


LINES OF *Most* RESISTANCE

This photomicrograph shows a cross-section of a drop forged machine part.

One good look at it will show you the reason for its extra strength and stamina. Note how the lines of flow follow the exact contour of the part—how the sinewy structure is securely knit together.

Here's maximum resistance in metal—the ability to withstand shocks and strains without flinching—and to do it day in and day out. It's the assurance of service, efficiency, and, in the long run, maximum economy.

This is a characteristic of all drop-forgings—and it's one of the reasons why Forgings by Phoenix are used in the manufacture of much of the equipment for our armed forces—equipment that must stand up under the most grueling punishment.

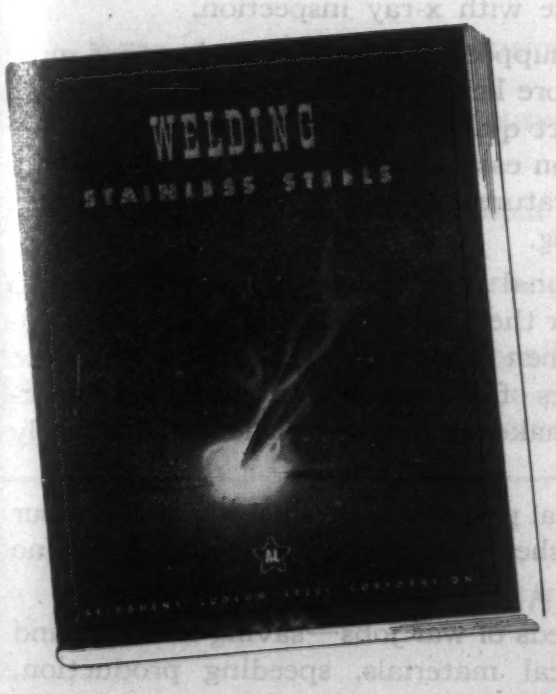
In planning your product for post-war markets you'll find it well worth while to consider the use of Forgings by Phoenix. Our engineers will gladly work with you—and there's no obligation.

Forgings by **PHOENIX**

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PENNSYLVANIA

ARE YOU WELDING STAINLESS STEEL?
HERE'S *New Light* ON THE SUBJECT



This book can save you time and avoid spoilage of vital alloys, both more than ever essential to the war program today. Describes and illustrates equipment, procedures, precautions. Request copies on your company letterhead, please.

ADDRESS DEPT. MA-6

SUCCESSFUL stainless steel welding, as many a shop has found out the hard way, puts a premium not only on knowing what to do, but also what to avoid doing—and why.

That is because the problem, first of all, is a double one as compared to ordinary carbon steel welding, since it calls for maintaining the corrosion resistance of the parent metal across the weld area, as well as its strength. Furthermore, although stainless steel welds easily, the various members of the stainless family differ considerably from carbon steel—and even from each other—in the physical and chemical phenomena they exhibit during the welding process.

Information, clear and complete, is the basic answer. We've supplied it in a new 64-page, full-color booklet, *"Welding Stainless Steels,"* covering all the commonly-used hand or machine methods of welding Allegheny Metal. Employing a new idea in graphic illustration, this book is, we believe, the most complete and understandable coverage of the subject yet published—a welding shop "bible" purposely made so clear and simple that it is also ideal for student training. ● *Write for your copy (see at left).*

AL
STEEL FOR THE NATION'S WELFARE

Allegheny Ludlum
STEEL CORPORATION
BRACKENRIDGE, PENNSYLVANIA

Branch Offices in Principal Cities . . . Allegheny Metal also handled by all Joseph T. Ryerson & Sons, Inc., Warehouses

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SIMPLIFY QUALITY CONTROL with easy-to-analyze x-ray inspection

Quality control of castings and weldments is easy, fast and absolute with x-ray inspection.

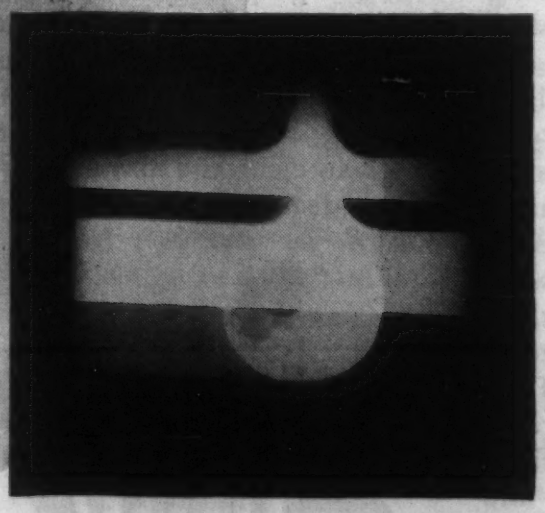
For example, suppose you have a casting that must be perfected before large scale pourings are practical. All you have to do to perfect quality is make small test casts—x-ray them—and you have an easy-to-analyze picture that shows up such variables as temperature of pour, location of gates and risers, ramming and shrinking.

Once perfected, an occasional x-ray is all that is necessary to maintain quality control—for there is no need for routine examination of every piece. Workmen learn quickly and pictorially the advantages and disadvantages of each modification in metal working procedures. And you make each test of quality absolutely —nondestructively.

Above all, you have pictorial proof for your customers that your products meet their established standards. No arguments—no renegotiations—no excuses.

X-ray is at work on hundreds of war jobs—saving machine and man-hours, conserving critical materials, speeding production, controlling quality and helping train workers. For more information, write for B-3159. It's a simplified booklet that shows you how and where x-ray can be used in industry. J-02024

LOOK INSIDE WITH X-RAY



This radiograph shows a blowhole in an aircraft casting . . . a typical example of how x-ray reveals subsurface defects.

Westinghouse

INDUSTRIAL X-RAY

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

This Pantograph Shoe of High-Chromium Iron Lasted 10 Years

TEN YEARS of sliding metal on metal is a severe test for any abrasion-resistant material. But that is the record of this pantograph shoe, the trolley contact for a mix car in a metallurgical plant. After 10 years the shoe made of about 27 per cent chromium iron is still in service. Shoes of other grades of hardened steel on the same job last four months.

Iron castings of 26-28 per cent chromium outperform other commonly used wear-resistant metals and alloys in applications involving extreme wear . . . particularly where there is considerable abrasion without undue shock. These castings are unusually easy to cast.

Castings of high-chromium iron have given outstanding service in dredge-pump liners, sludge-pump liners for oilwell drilling, equipment for coke crushing, screening, and conveying systems, and rock-handling equipment such as crusher jaw plates, crusher rolls, and chute liner plates.

High-chromium high-carbon irons are readily made in either the crucible or electric furnace by melting procedures customary for high-chromium steels. For information on their composition, heat-treatment, and physical properties, write for the booklet, *Abrasion-Resistant High-Chromium* Iron.

★ *BUY UNITED STATES WAR BONDS AND STAMPS* ★

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
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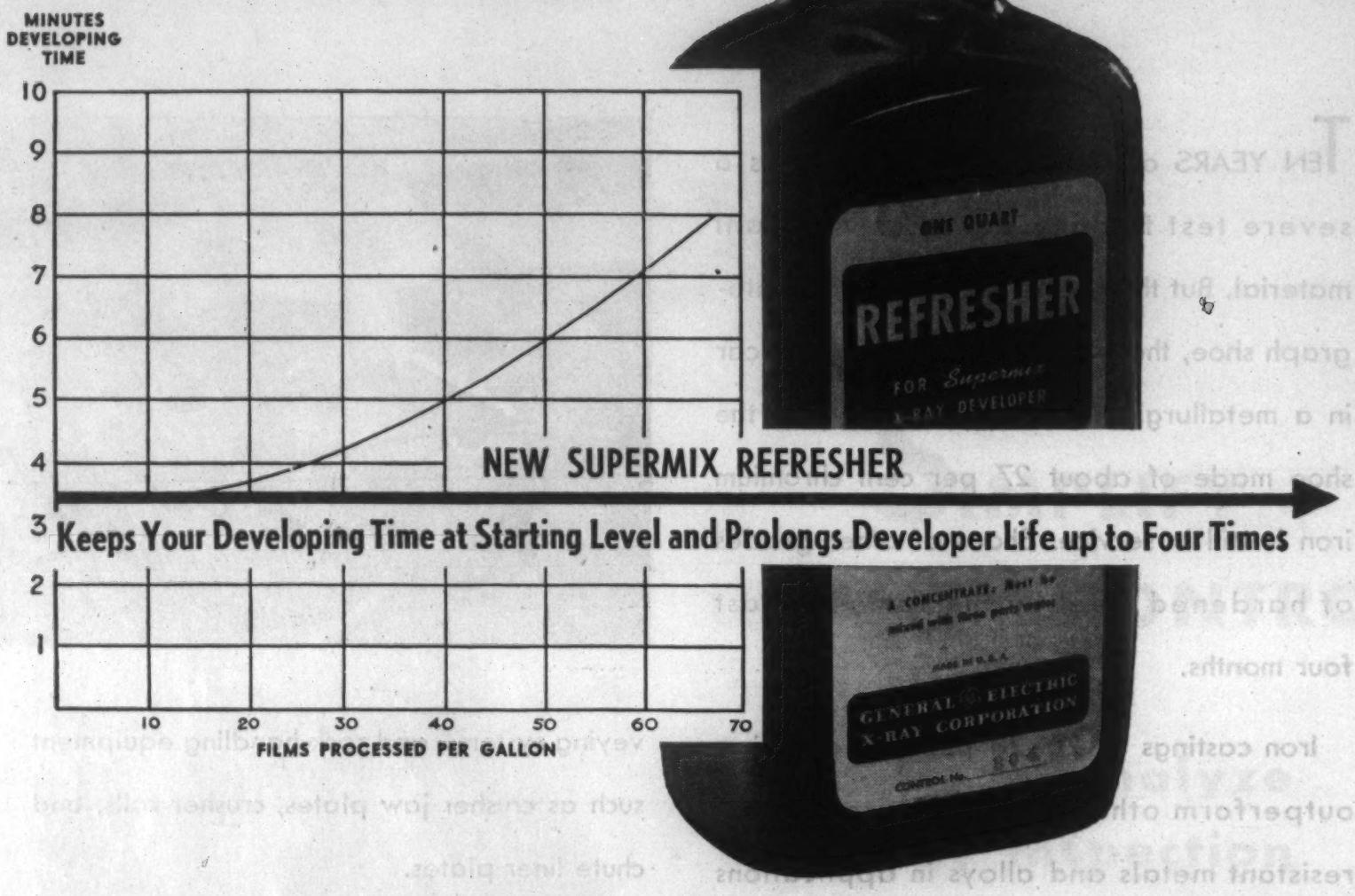

NEW SUPERMIX REFRESHER

Keeps Your Developing Time at Starting Level and Prolongs Developer Life up to Four Times

In your x-ray film-processing room, why use solutions made of conventional powders when with Supermix solutions you get better results, quicker and more economically?

With Supermix liquid concentrates you can develop films in 3 minutes and clear them in 1. Can you do this with conventional powders? Of course not, nor can you enjoy the constant developing time provided by Supermix Refresher.

The quality of the films developed in Supermix is better every time than if the same films were processed with conventional powdered chemicals. Supermix is unsurpassed for bringing out inherent contrast, density, and detail. You can't afford to diagnose from films of inferior quality, so use Supermix.

Do you like the laborious unnecessary work of mixing solutions with conventional powders? Avoid it with Supermix liquid concentrates. Simply pour them into the tanks and add water at the correct processing temperature. They're ready to use.

Supermix Developer and Fixer, despite their higher initial cost, are actually more economical to use than customary powders, since in solution they process from 50 to 70% more films. And the use of Supermix Refresher makes the developing solution last up to 4 times longer. In these hard-pressed times how can you afford not to use Supermix? Order today—address Dept. N212.

Today's Best Buy
U. S. War Bonds

	Developer	Refresher	Fixer
To make 1 gal.	$1.00	$1.15	$1.00
To make 3 gals.	2.75	....	2.70
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ARMY E NAVY

GENERAL ELECTRIC X-RAY CORPORATION

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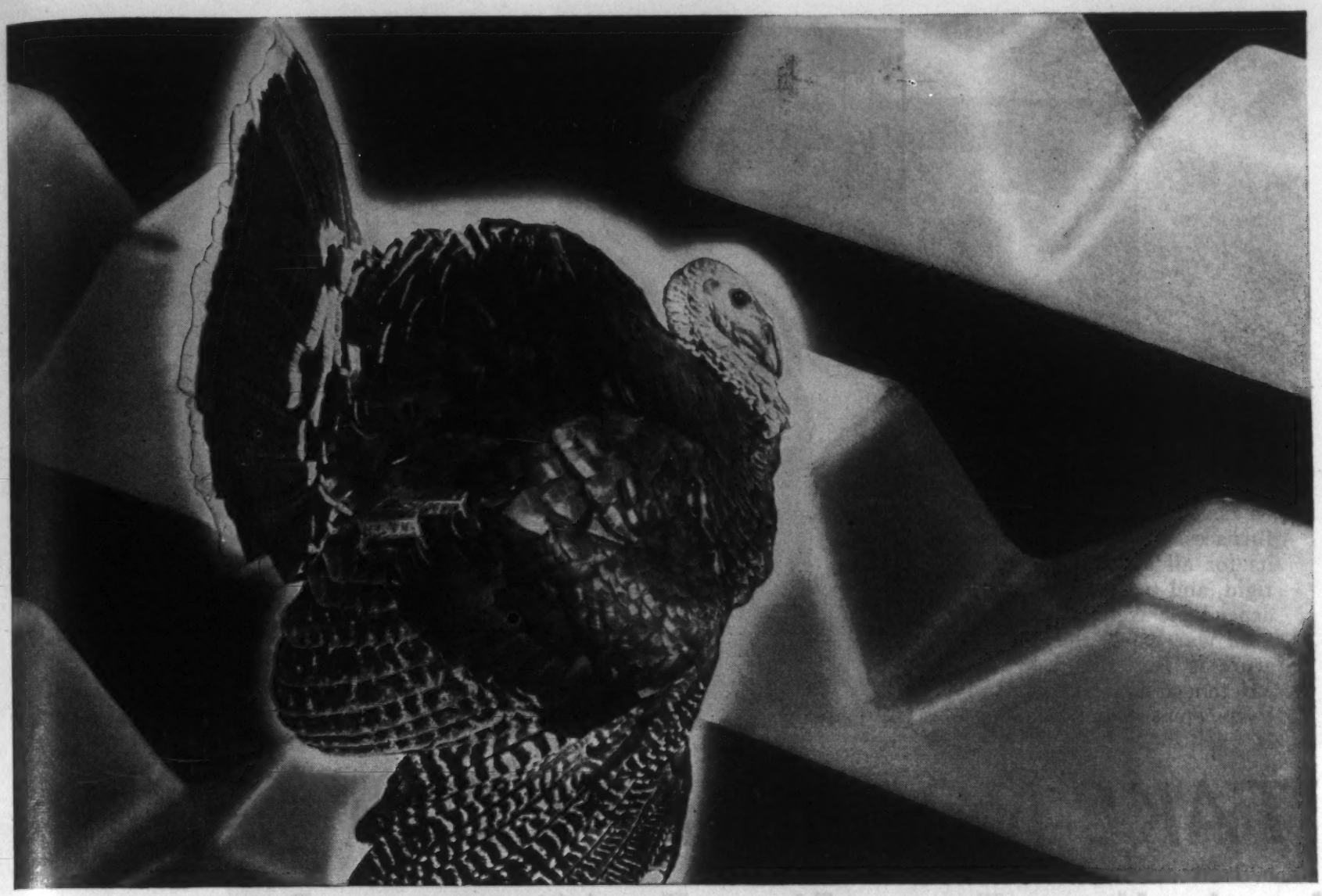


LET'S TALK TURKEY ABOUT ALUMINUM ALLOYS

• It's about time to stop talking about *secondary* aluminum. *Any* aluminum alloy which meets the rigid specifications of the government and of technical societies is equal to its task. We—the undersigned companies—produce such alloys, under strictest laboratory controls.

The members of the Aluminum Research Institute are meeting the demands of war production with furnaces that smoke by day and flare by night, to furnish the ingots imperatively needed. We will meet the demands of postwar industrial expansion in common sense American fashion, with aluminum alloys that will play a crucial part in peacetime planning and achievement.

It's time to talk turkey: The war has proven the value of our product. The aluminum alloys that we produce have come of age. No longer should they be called "secondary." In peace as in war, our aluminum alloys will do a "primary" job.

Aluminum and Magnesium, Inc.,
Sandusky, Ohio

The American Metal Company, Limited
New York City

Apex Smelting Co.
Chicago, Illinois

The Cleveland Electro Metals Co.
Cleveland, Ohio

Federated Metals Division American Smelting and Refining Company
New York City and Branches

General Smelting Company
Philadelphia, Pennsylvania

William F. Jobbins, Inc.
Aurora, Illinois

R. Lavin & Sons, Inc.
Chicago, Illinois

The National Smelting Company
Cleveland, Ohio

Niagara Falls Smelting & Refining Corp.
Buffalo, New York

Sonken-Galamba Corporation
Kansas City, Kansas

U. S. Reduction Co.
East Chicago, Indiana

ALUMINUM RESEARCH INSTITUTE
308 West Washington Street, Chicago 6, Illinois

One hundred and fifty rough-forged crank cases for warplane engines, just after being normalized on one of the Massachusetts Steel Treating Co.'s (Worcester, Mass.) National gas-fired furnaces. Temperature limits for all aircraft parts are rigid, and to assure the most dependable control for such vital war work, the temperature is regulated by the Micromax Electric Control Pyrometers shown below.

"TAKE-NO-CHANCES" Policy

Leads Heat-Treat Firm To Micromax Pyrometers

Control panel for two two-zone Mass. S. T. Co. furnaces; the Micromax Pyrometers at the rear regulate furnace shown in upper photo; others regulate a smaller furnace. In each case there's a Micromax for the front zone and one for the rear. Each Micromax throttles gas fuel *in strict proportion* to the needs of its end of the furnace, and the result is a control so close that you'd usually need a magnifying-glass to see the "wiggles" in the temperature record.

"Never take a chance with a customer's goods—that's our policy," say the owners of the Massachusetts Steel Treating Co., "and that's why we use Micromax Control Pyrometers on our furnaces. If a customer says 'Heat these forgings to 1700' and we use Micromax Controllers to regulate the heat, we know and our customer knows that we took no chances on that temperature equipment. Nobody even questions it—Micromax is standard for best temperature control."

Several very specific features back up this opinion of Micromax. It is so fully automatic that it runs for days at a time without being touched. It standardizes itself; holds several weeks' supply of ink and chart paper; signals when it needs either ink, chart or dry cells. And it's mechanically more like a machine-tool than an instrument; it has cut gears; thick shafts; sturdy frame castings. The assembly is expertly well-fitted and snug. The entire Pyrometer is designed to take full responsibility for important temperatures, and handle them with complete satisfaction.

If you have a pyrometer problem, an L&N engineer will gladly help solve it. If a catalog meets your present needs, ask for either N-33A on Micromax for Thermocouples, or N-33B, Micromax for Rayotubes.

Jrl Ad N-33-620(7)

depends on me!

A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

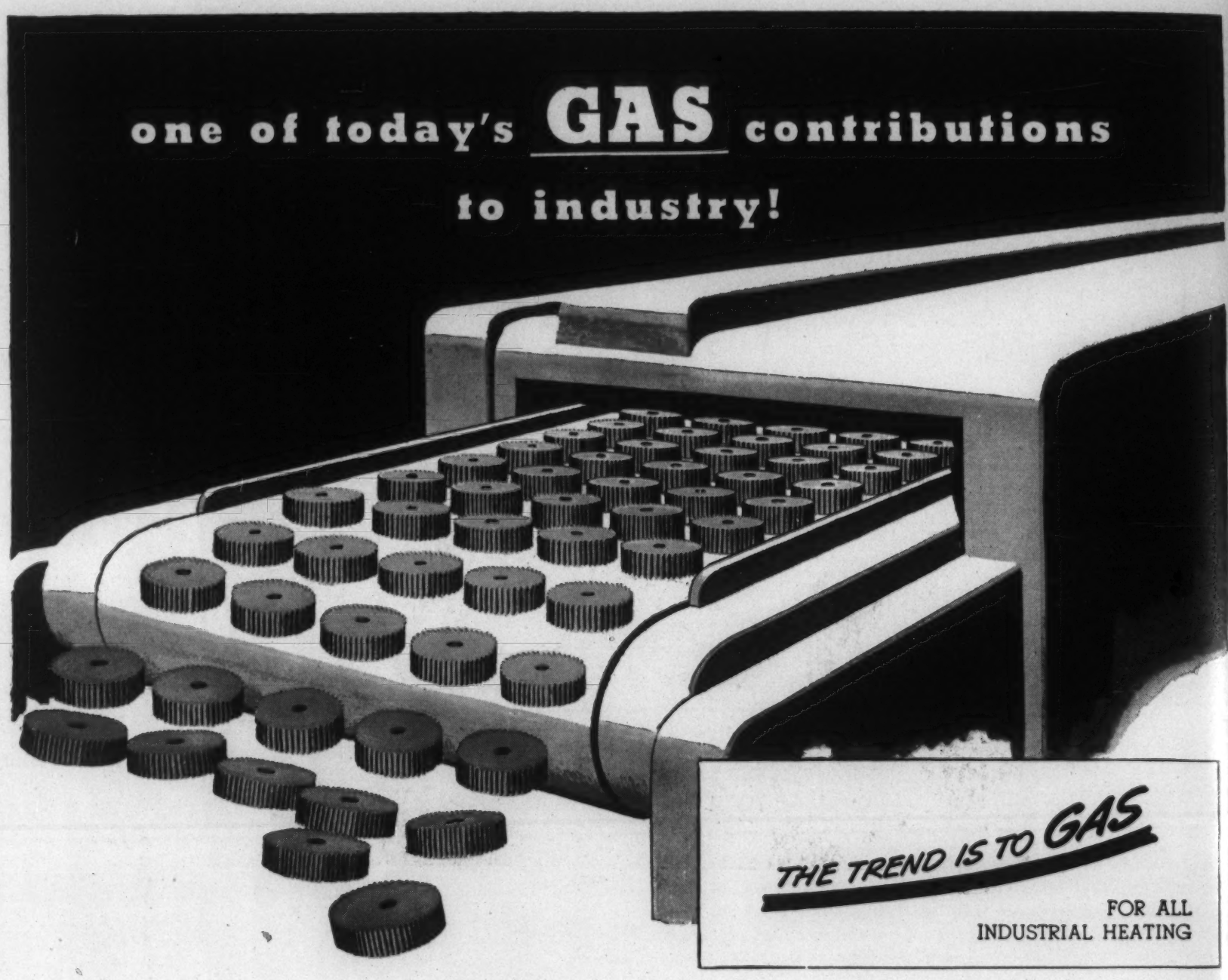
On this Christmas

We, too, offer humble thanks . . . . thanks that we in X-ray have been privileged to lend our strength toward the salvaging of the lives of many in our Armed Forces, thus helping in their restoration to their loved ones.

PICKER X-RAY CORPORATION

STREAMLINED HEAT-TREATING...

one of today's **GAS** contributions to industry!



THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

War's impact has evolved new techniques which will be valued post-war procedures

To "get thar fustest with the mostest men" means getting there "fustest" with machines of war as well—tanks, planes, ships, bombs, torpedoes, and a thousand other essentials. To do that, American industry has had to perfect new ways of turning out war materials—better, faster.

Because heat-treating enters so largely into the making of most war materials, Gas has played a vital part in this rapid evolution of techniques. One aspect has been the creation of a new technique by which heat-treating with Gas has been integrated with production so that each operation, whether heating or quenching, is not a separate task but an integrated part of the whole operation.

All this new development will be available to industry after the war and will unquestionably help to produce peacetime goods faster and better and at immensely lower cost. Ask your Gas company for help in fitting Gas to your post-war needs.

AMERICAN GAS ASSOCIATION
INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK

Keeps the "flak" flying . . .

Safety underfoot gives confidence to American gun crews . . . helps them to keep the "flak" flying when enemy aircraft attack. Here is a real job for "A.W." Rolled Steel Floor Plate—guarding our men against dangerous slipping and falling accidents. Fire-proof, heat-proof, oil-proof, crack-proof. "A.W." Floor Plate protects men essential in the war effort wherever they may be. Ends floor troubles for good. Folder on request.

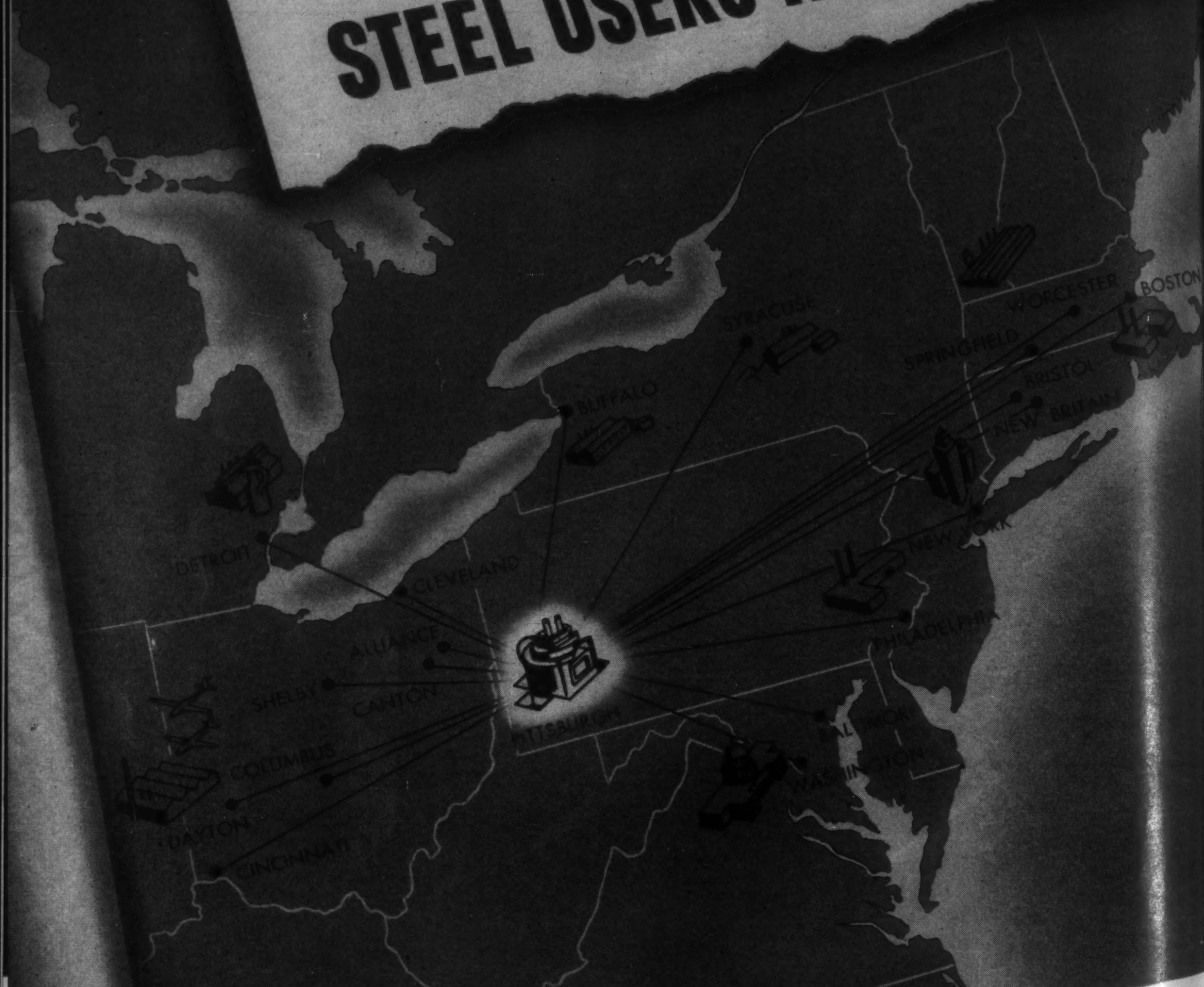
Other products include Plates, Sheets, Billets, Blooms, Slabs—Carbon, Copper or Alloy analyses.

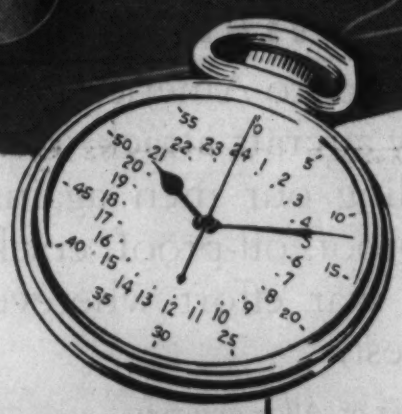
ALAN WOOD STEEL COMPANY

MAIN OFFICE AND MILLS: CONSHOHOCKEN, PENNSYLVANIA : SINCE 1826. District Offices and Representatives: Philadelphia, New York, Boston, Atlanta, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, St. Paul, New Orleans, Pittsburgh, Roanoke, Sanford, N. C., St. Louis, Los Angeles, San Francisco, Seattle, Montreal.

Vital to Victory . . . get in the SCRAP

BIG NEWS FOR STEEL USERS IN THE EAST...





In war or peace—Time can make the vital difference between success and failure.

If you are located within this strategic area . . . our metallurgical engineers will gladly discuss with you how much better—and faster—your requirements in high quality steels can be served by this increased electric furnace capacity and by the new and advanced heat-treating facilities now available here in Pittsburgh.

UNITED STATES STEEL

New Electric Furnace capacity at Pittsburgh now ready to serve your alloy steel needs

AT our Duquesne Works, right in the heart of the eastern industrial district, facilities to produce approximately 158,400 tons of electric furnace alloy steel ingots per year are now in operation. As an important part of this expansion program, special equipment for heat treating approximately 25,000 tons of rolled alloy steel products will now be readily available to eastern users.

This new plant has been designed to produce the highest quality Electric Furnace Steels suitable for use not only in aircraft construction, but in tank parts, guns, bearings and in other applications wherever superior quality steel is required—either now or in the future.

In conjunction with this new electric furnace capacity, our many and varied rolling mill facilities operating in the Pittsburgh district, can be utilized not only to produce the conventional round and square bars, but a full range of flat-rolled products including plates, sheet, strip, etc., as well as sections and shapes.

To ensure the maintenance of uniformly highest quality in the steel turned out, this plant is under the charge of some of America's foremost metallurgists and finest steel makers, whose constant watchword is "Quality First".

To back up these men, and to translate their skill and experience into reality, the equipment with which they work embodies the most advanced ideas in electric furnace steel production.

Latest type high efficiency Heroult Electric furnaces with capacities ranging from 7 to 70 tons each, provide a wide flexibility.

Automatic combustion control of the soaking pits insures uniformity in heating the steel.

Also automatically controlled, a unique seven-chamber electrically heated, continuous annealing and heat-treating furnace insures superior and exact physical properties in the heat-treated product. For spheroidize annealing and for such annealing operations requiring high temperatures together with controlled slow cycles, three 25-ft. and two 36-ft. gas-fired car bottom furnaces are further available. They provide the flexibility required to handle small orders as well as full heats when necessary.

This new plant in Pittsburgh, which supplements the output of our Chicago mill, is now ready to expedite the servicing of your wartime needs for fine electric furnace steels. In the future it will be available to serve your peacetime requirements — both in small and large tonnages—with the same high quality for which U·S·S Carilloy Alloy Steels are noted.

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

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STEEL NEEDS MORE SCRAP NOW SEND IT IN!

NICKEL AIDS THE CONSTRUCTION INDUSTRY

to KEEP 'EM WORKING!

Engineers who design construction equipment can take pride in the construction industry's greatest achievement...its part in building America's "Arsenal of Democracy."

For they contributed to that amazing success, even long before the war started. They designed the tools with which the job was done...found ways to make equipment durable, and thus prevented many a breakdown of machinery at this critical time when nothing must interfere with the drive toward Victory.

Familiar to them, as a means of giving longer life to construction equipment, is the widespread use of Nickel Alloys. Those engineers have learned from long experience that Nickel imparts toughness, strength, and corrosion resistance to ferrous and non-ferrous metals, and thus assures improved performance under the most severe conditions.

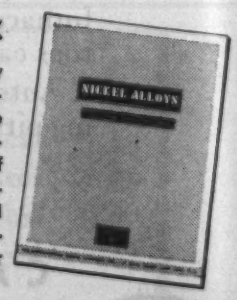
Among them, as with men in many other industries, the saying is that "a little Nickel goes a long way" toward increasing dependability of machine parts—from gears to scraper blades, from dipper teeth to crusher rolls.

The experience of contractors, engineers, and machine operators in the field supports this conviction of the designing engineers...proves that the products of leading manufacturers stand up longer under the stress of exacting service.

It has been the privilege of INCO engineers and metallurgists to cooperate with the construction industry for many years. To men in all industries who desire assistance in the selection, abrication, and heat treatment of ferrous and non-ferrous alloys, the International Nickel Company cordially extends an offer of counsel and data.

New Catalog Index

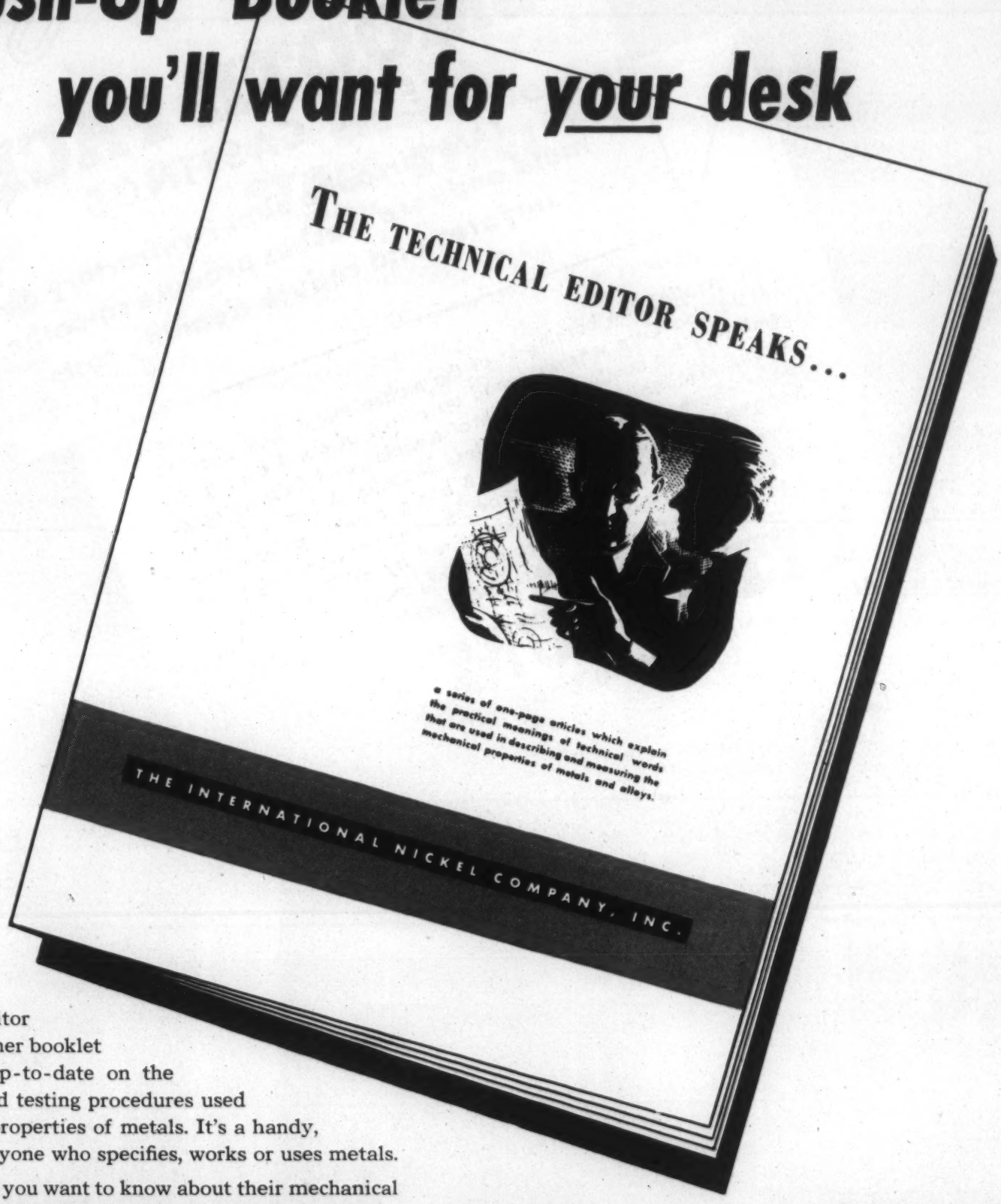
New Catalog C makes it easy for you to get Nickel literature. It gives you capsule synopses of booklets and bulletins on a wide variety of subjects—from industrial applications to metallurgical data and working instructions. Why not send for your copy of Catalog C today?



* Nickel *

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall St., New York 5, N. Y.*

A "Brush-Up" Booklet you'll want for your desk



"The Technical Editor Speaks" is a refresher booklet that brings you up-to-date on the technical terms and testing procedures used in measuring the properties of metals. It's a handy, useful guide for anyone who specifies, works or uses metals.

It tells you what you want to know about their mechanical properties . . . how they are determined and how the information is used to judge metals for practical applications. Compiled from a series of articles written by THE DEVELOPMENT and RESEARCH DIVISION of THE INTERNATIONAL NICKEL COMPANY . . . it includes discussions and descriptions of the properties listed below.

Send for a complimentary copy . . . or copies . . . today. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

24 PAGES OF INFORMATION ABOUT METALS

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Yield Strength, Proportional Limit, Proof Stress, Rigidity, Modulus of Elasticity, Ductility.

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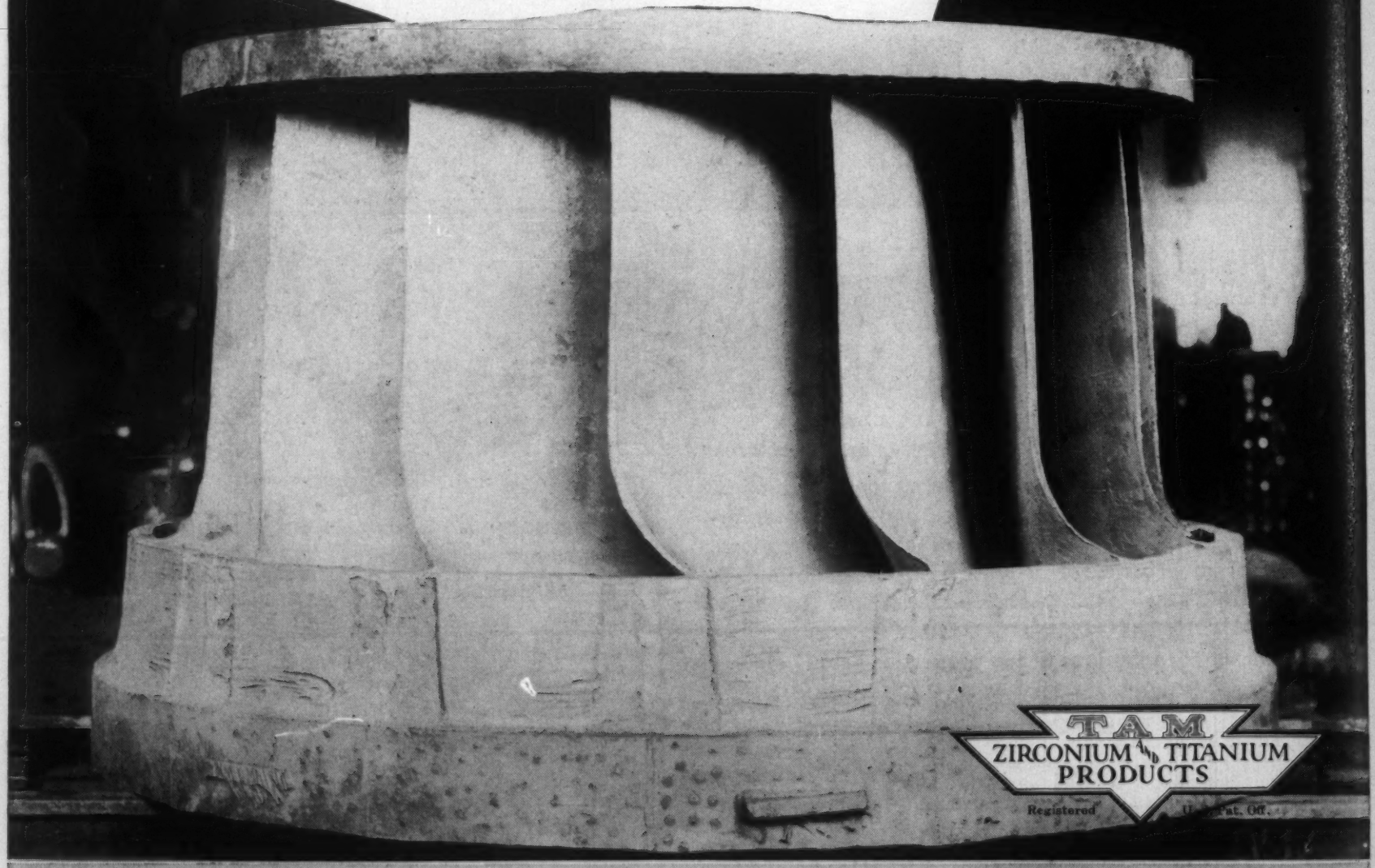
TAM Zirconite super-refractory mold and core washes produce smoother surfaces and reduce cleaning costs

By resisting the burning-in of the molten metal, TAM Zirconite Mold and Core washes speed up output of good castings by reducing the number and time of cleaning and finishing operations. Available in three grades: Zirconite A has a melting point above 3775° F.; Zirconite B has a melting point above 3600° F.; and Zirconite C, for special uses, has a melting point above 3600° F. They are quickly mixed by adding to water, and can be applied by either spraying, swabbing or painting on cores and molds. Write for complete details, today.

TITANIUM ALLOY MANUFACTURING COMPANY

Zirconite Wash was used on this 94,000 pound .30-.35 carbon steel casting—11'6" high 14' diameter. Of special interest is the fact that no nails were used in the facing.



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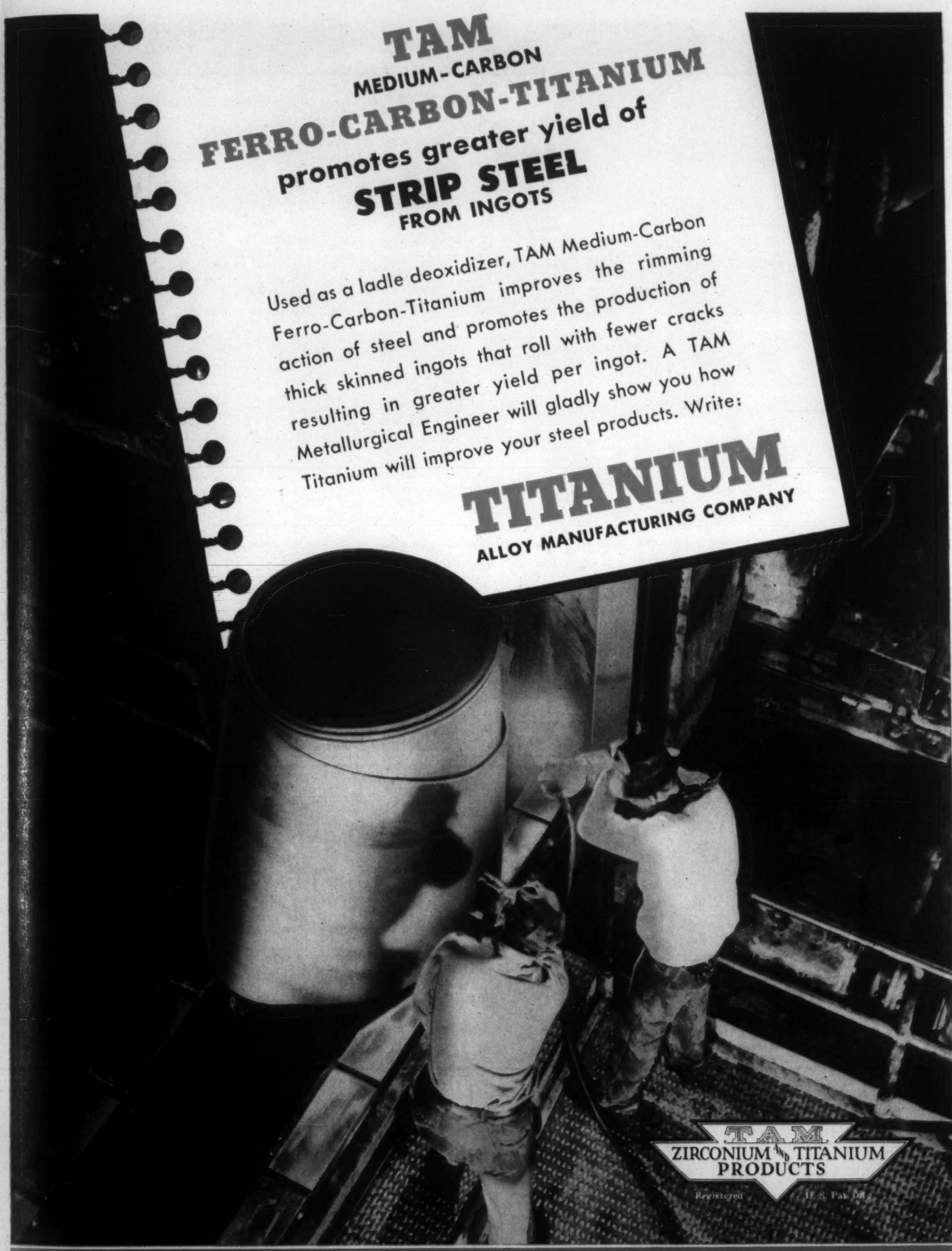
MEDIUM-CARBON FERRO-CARBON-TITANIUM promotes greater yield of STRIP STEEL FROM INGOTS

Used as a ladle deoxidizer, TAM Medium-Carbon Ferro-Carbon-Titanium improves the rimming action of steel and promotes the production of thick skinned ingots that roll with fewer cracks resulting in greater yield per ingot. A TAM Metallurgical Engineer will gladly show you how Titanium will improve your steel products. Write:

TITANIUM ALLOY MANUFACTURING COMPANY



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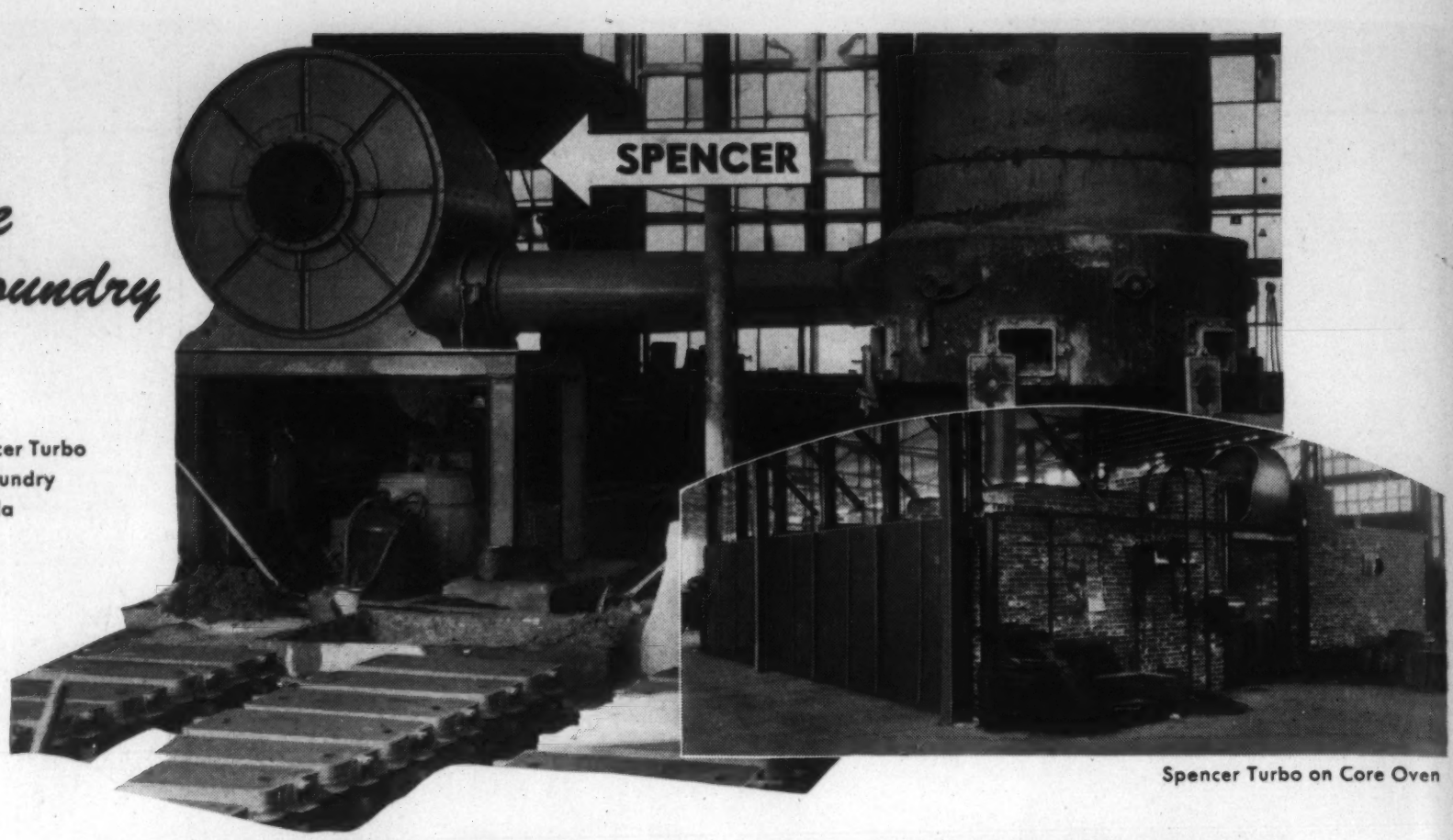
In the Foundry



Spencer Turbo on Foundry Cupola

Spencer Turbo on Core Oven

SPENCER HARTFORD TURBO-COMPRESSORS

Spencer Turbo-Compressors serve foundries in many ways. For cupolas, the large multi-stage Spencer Turbos with wide clearances and long life are distinguished by the fact that a constant air pressure is automatically maintained regardless of conditions inside the cupola. A calibrated ammeter permits accurate control of the volume of air from any point on the pouring floor, or automatic air weight control can be furnished when desired for core ovens, heat treating and other forms of gas and oil fired equipment, Spencers are the recognized standard. They have been recommended repeatedly by the leading manufacturers of foundry equipment for more than a quarter of a century.

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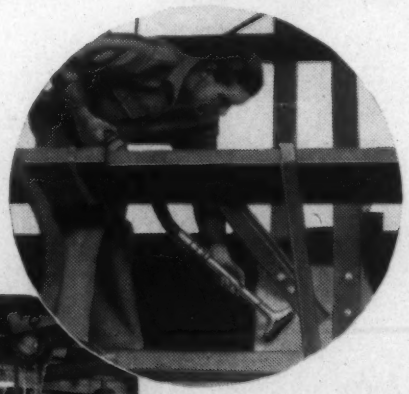

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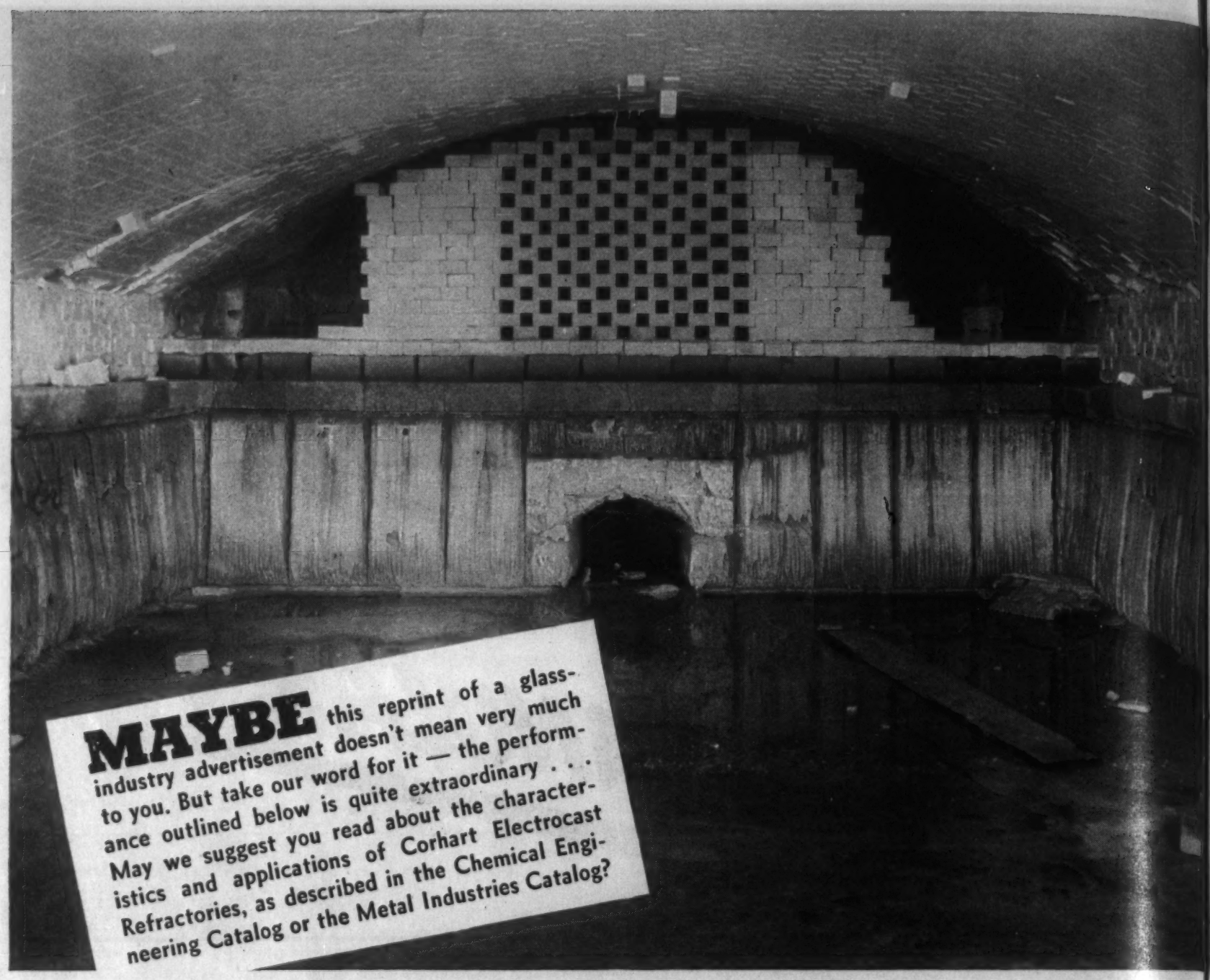

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FOR 31 months, the furnace above operated at high production on milk-bottle glass. It is obvious that in a campaign of this length, with a floor-level throat, no refractory could survive unless it were possessed of extraordinary quality and resistance.

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DECEMBER, 1943

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Metallurgical Help in the Postwar Planning Picture

Improved Copper-Base Alloys Present Many Advantages For New Product Design

Practically all people in industry have been planning for the postwar period, although some call it "forward planning." At any rate, many of their ideas have at least begun to crystallize by this time. Designs for improved and new articles are undoubtedly being made in many places. These may call for metals or alloys with new combinations of characteristics.

Bridgeport's Metallurgical Laboratory can be of great service to postwar planners. Well directed development work to anticipate the requirements should be carried out now. But the Laboratory must be supplied with facts or specifications to which they can work. Solving metal problems early in the game will eliminate many unnecessary headaches on the finished product.

Choice of Materials Dependent On Economic Considerations

Much has been said and published concerning probable competition between copper-base alloys and light metals and plastics. However, the choice of material for any given service will always be based on practical manufacturing and economic considerations. If copper-base alloys, or any material for that matter, will give sufficiently better service than competing materials per dollar expended, then and then only will they be used.

The outstanding characteristic of the lighter metals and their alloys is their low specific gravity. Where lightness is of prime importance as, for example, in transportation equipment such as airplanes, railroad cars, trucks, buses, boat superstructures, and in moving parts such as piston rods and similar applications, the light metals will replace large tonnages of steel.

Advantages of Copper-Base Alloys

The chief reasons why copper-base alloys are used for modern devices can be listed somewhat as follows:

1. Ease of cold-working
2. Ease of hot-working
3. Corrosion resistance
4. Strength or hardness
5. Fatigue strength
6. Wide range of physical properties controlled by simple processing variations
7. Machineability
8. Conductivity, electrical and thermal
9. Resistance to season-cracking
10. Resistance to abrasion
11. Color
12. Ease of finishing (plating, lacquering, etc.)
13. Spring qualities
14. Ease of brazing, soldering, welding
15. Retension of physical properties at moderately elevated temperatures

In actual practice a combination of several of the above properties are required for every item manufactured.

When we consider one after another of these characteristics and compare them with the lighter metals and their alloys as well as with plastics, it becomes evident that there are very few fields where the comparison is not in favor of the copper-base alloy. Of course, there are some marginal cases where expected postwar lower prices on light metals may topple the balance, but such cases are few.

Research Provides Improved Copper Alloys At Reduced Cost

In the field of copper-base alloys, Bridgeport reports much progress in recent years because of improved efficiency in mill processing due to better and more powerful equipment and because of the vast amount of research work done to improve techniques and the alloys themselves, in addition to the development of new alloys. Much work is being done in studying the properties of existing and competing alloys as well as on corrosion research and miscellaneous investigations. Naturally many new data are available for postwar planning. The user of metals is now in a better position to select the alloys with the optimum combination of suitable characteristics to help him attain a superior product at a minimum production cost.

Typical of Bridgeport's policy of research and development is the work which the Laboratory is conducting in the field of corrosion—its causes and its remedies. Illustrated here are the results of one such corrosion problem. Depicted in the photograph at the top are samples of various metals and alloys which were, without exception, attacked by corrosion at the waterline after partial immersion for 58 days in a 10% sulphuric acid solution. Below are duplicate samples, also tested at Bridgeport's Laboratories, which showed only slight attack after partial immersion for the same length of time, but with the addition of .05% corrosion inhibitor to the sulphuric acid solution.

CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist at the Bridgeport Brass Company

STEAM-EROSION

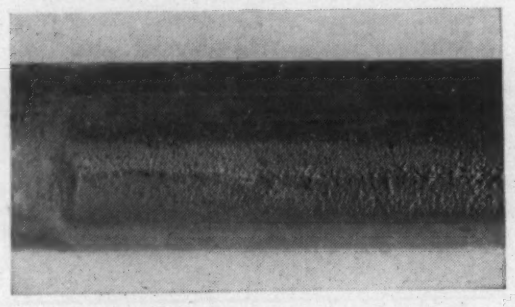
In the April and May, 1943, editions of the COPPER ALLOY BULLETIN, we discussed the effect of gas bubbles in rapidly flowing water in accelerating the corrosion of metals. Here, deep pitting of a metal is accelerated by the presence of a gas phase (bubbles) in a rapidly flowing liquid phase (water). In the erosion-corrosion of metals by steam, we find the pitting or wearing away of the metal accelerated by the presence of a liquid phase (water) in a rapidly moving gas phase (steam.) The action of wet steam travelling at high velocities, 3,000 to 4,000 feet per second, is quite surprising. Copper, brass, bronze, copper-nickel alloys, stainless steel, etc., may be eroded at rates of .001″ up to .050″ or more per year, depending upon the number and size of the water droplets, the steam

(Continued on following page, column 1)

CAUSES OF CORROSION

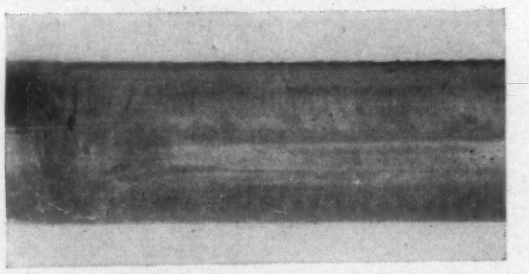
(*Continued from preceding page, column 3*)

velocity, and the composition of the steam. A number of investigations indicate that the size of the droplets of water in the steam is of great importance. The steam-erosion-corrosion or steam-erosion of metal by wet steam is to be found in all parts of equipment handling steam, such as steam turbine blades, condenser tubes, valve seats and discs, piston rings in steam engines, etc.



(*Above*) Photograph of exterior of hard-drawn copper condenser tube showing localized roughening and pitting produced by steam-erosion. Note absence of attack where support plate protects tube.

(*Below*) Photograph of same tube rotated to show streaming. Note profile of eroded copper.

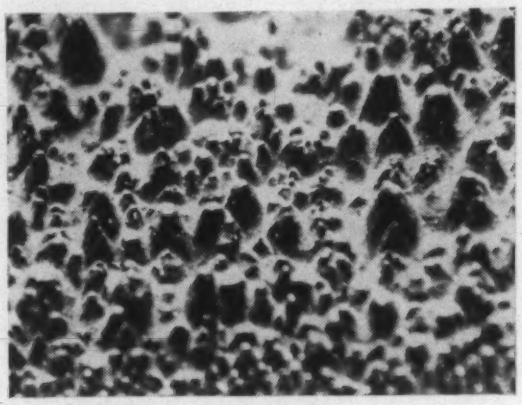


Steam-Erosion of Condenser Tubes

The accompanying photographs and photomicrograph give several views of the erosion produced on a hard drawn tube located near the throat of a condenser. Steam entered the condenser from the turbine which was located immediately above, struck a deflector plate and then glanced off the side of the copper tube. The photomicrograph (Figure 3) shows that the roughened surface actually consisted of a large number of copper cones all tilted in one direction, showing a striking resemblance to the strange formations produced by erosion of rocks in the western states.

Prevention of Steam-Erosion

Numerous attempts have been made to eliminate steam-erosion of condenser tubes. One procedure consists of removing as much moisture as possible from the steam as it leaves the last wheel of the turbine, so that a fairly dry steam reaches the condenser tubes. Since this cannot always be realized, another alternative consists of installing more steam-erosion resistant materials in the area where the impingement occurs. Certain hardened stainless steels have been used with success; the soft alloys are not as resistant. Another alternative is



(*Above*) Photomicrograph of same tube showing tilted cones formed by steam-erosion (10x). Tops of cones represent original surface.

the spraying of stainless steel (by the metal spraying or metallizing process) on thoroughly cleaned sections of tubing which show evidence of erosion. This has helped in delaying the failure of the tubes by steam-erosion. Theoretically, the life of such a condenser tube could be prolonged indefinitely by repeatedly metal spraying the tubes at intervals when the sprayed metal erodes away. It seems that this method is worthy of more widespread use than is now being made of it. In dry steam regions or low velocity regions, Aluminum Brass, Duronze IV, Admiralty metal, copper, Cupro Nickel, etc. generally give very satisfactory service. (Actually in service, most condenser tube failures occur on the water side.)

Steam-Erosion of Valves

In steam valves, this phenomenon of erosion may be very severe and is commonly referred to as "wire-drawing." The valve seat or disc, or both, may be deeply eroded by wet steam. The erosion or wire-drawing may take the form of a single deep clean groove or a cavity or a number of grooves or cavities. The erosion of steam valves can be prevented to a considerable extent by:

1. Incorporating streamlined interior passages in the design of the valve and providing traps for removal of moisture before the steam enters the valves.
2. Using materials in valve seat and disc construction that are designed to provide greater resistance to steam-erosion-corrosion.

Brass valves are commonly used to handle steam up to 325° F. (approximately 100 pounds pressure, and if conditions are not too severe, up to 425° F. (approximately 300 pounds pressure.) Brass valves are seldom used for steam services above 500° to 550° F. For severe operating conditions in this temperature range, stainless steel trim is used. For higher temperatures, stainless steel or Stellite trim give satisfactory service.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

A Roll Type Forming Machine is now available with a 20" throat which will handle sheet metal up to 20-gage steel. Its rolls are interchangeable to combine operations of heading, crimping, flanging, trimming, turning and wiring. The hinge-mounted, motor is belt connected to the roll shafts. **(No. 510)**

An Illuminating Grinder Shield has been designed to protect the machine operator from flying particles and at the same time provide adequate lighting for his work. Designed for easy installation, this grinder shield is equipped with concealed lamps which are said to be of long-lasting quality and to provide light that is easy on the eyes. **(No. 511)**

A Foot-Operated Press for riveting, piercing, cutting, stamping and other light jobs has been made available. In two styles, for bench mounting or with floor pedestal, the press is equipped with a pendulum lever which, when kicked, moves the ram down onto the work at pressures up to two tons. The weight of the lever returns it to its initial position after each operation. **(No. 512)**

A Midget Pneumatic Vise with a maximum jaw-opening of two inches has been announced as suitable for light milling, drilling and tapping operations as well as general bench work. The moving jaw is operated by a special air cylinder, enabling the user to set the jaw travel at any point of the maximum opening. Compactly designed, it measures 10" in overall length and weighs only 12 pounds. **(No. 513)**

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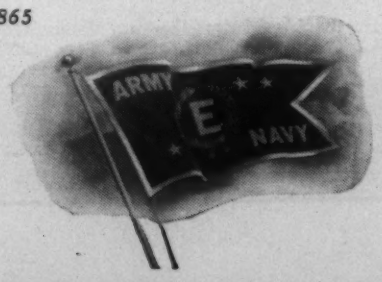
BRIDGEPORT 

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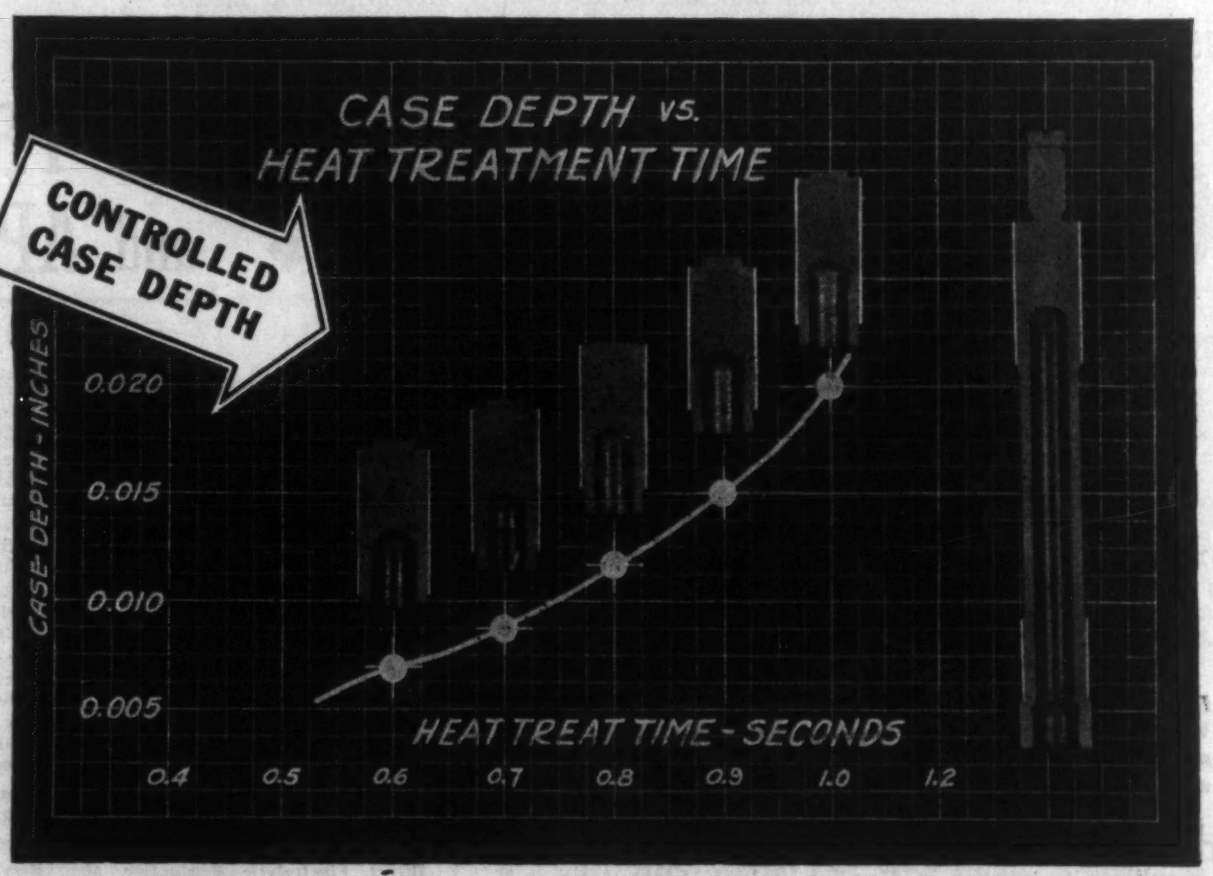

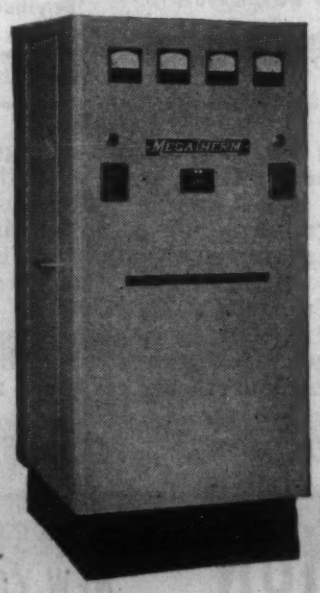

The above illustration shows actual test data and parts taken from a specific application. It illustrates how accurate control of case depth was accomplished by the selection of heat-treat time. These bearing surfaces were case hardened by the MEGATHERM PROCESS *after finish grinding.* There was complete freedom from warping and distortion.

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Chief Engineer, National Reconditioning Company, Inc., New York
Chairman of the Board, Wah Chang Trading Corporation, New York

and CHUNG YU WANG, M. INST. M.M.

University Medallist, Columbia University
Technical Expert, Ministry of Economic Affairs, China
Director of Research, National Reconditioning Company, Inc., New York

The increasing importance of tungsten in the metallurgical and electronic industries has evoked a need for a comprehensive treatment of its geology, processing and uses. This volume has been designed to meet that need. Written by two outstanding experts in the field, one of whom is consultant on tungsten to the U. S. Government, it presents detailed discussions of the occurrence, composition and preparation of tungsten ores in all parts of the world, which will be of immediate and permanent value to geologists, mining engineers and metallurgists in general. This material is accompanied by maps and other illustrations, including three striking color reproductions of various types of tungsten ores. The uses of tungsten in high-speed steels, ferrous and non-ferrous alloys, wire, dies and drill bits and electrical equipment are described, and chapters are also devoted to the metallurgy, chemistry and economic position of tungsten. In all cases the presentation is precise, accurate and thorough-going. This volume should be in the possession of all chemists, metallurgists, mineralogists, and geologists, and any others concerned with the uses or properties of this strategically important metal.

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Beryllium ◆ ◆ ◆ ITS PRODUCTION and APPLICATION

By Zentralstelle fur wissenschaftlich-technische Forschungsarbeiten des Siemens-Konzern

Translated by

RICHARD RIMBACH

and

A. J. MICHEL

NOTE: The demands created by the war and the fact that this is the only book on this subject in English, have made it necessary to reprint this volume originally published in 1932.

●

First-hand results of the development of industrial Working Methods and the investigation of the properties and commercial evaluation of this remarkable element.

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NOT only is this the first thorough treatise on beryllium to appear in English, which fact alone makes it welcome to American metallurgical engineering, but it presents in concise and usable form what might be termed "all about" this coming metal. The authoritativeness of this book arises from the fact that it is essentially an account of ten years' work on Beryllium and its alloys by the very men who systematically conducted these researches, augmented by reports contributed by other workers in this field. This book will be found indispensable not only to workers in the more obvious field of light-metal alloys, but equally to those interested in the alloys of the heavier metals. Some of the two dozen separate articles, each by a leading specialist, deal with analytical chemistry of beryllium; with the thermal reduction of the metal; with the production of the metal and the direct production of its alloys by electrolysis; with the theory of age-hardening on the bases of the Be-Cu alloys; with the constitution, properties and age-hardening of these alloys; with the effect of age-hardening as shown by the behavior on etching, the electrical conductivity, the density and by X-ray spectrograms; with ternary copper-base alloys (Cu-Sn, Cu-Zn, Cu-Al) containing Be, with the effect of additions of phosphorus on the Be-Cu alloys; with Ni-Be alloys; with Fe-Be alloys; with magnetic measurements on these alloys, etc., etc.

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The Analytical Chemistry of Beryllium.
The Occurrence of Beryllium.
The Thermal Reduction of Beryllium.
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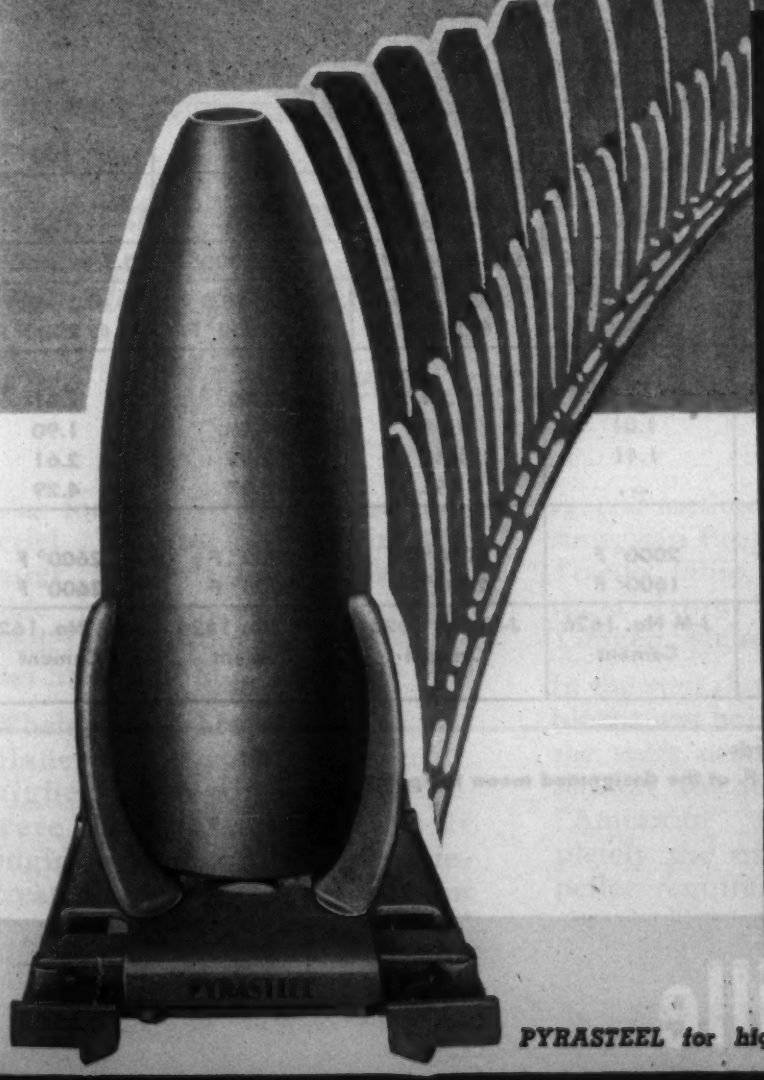

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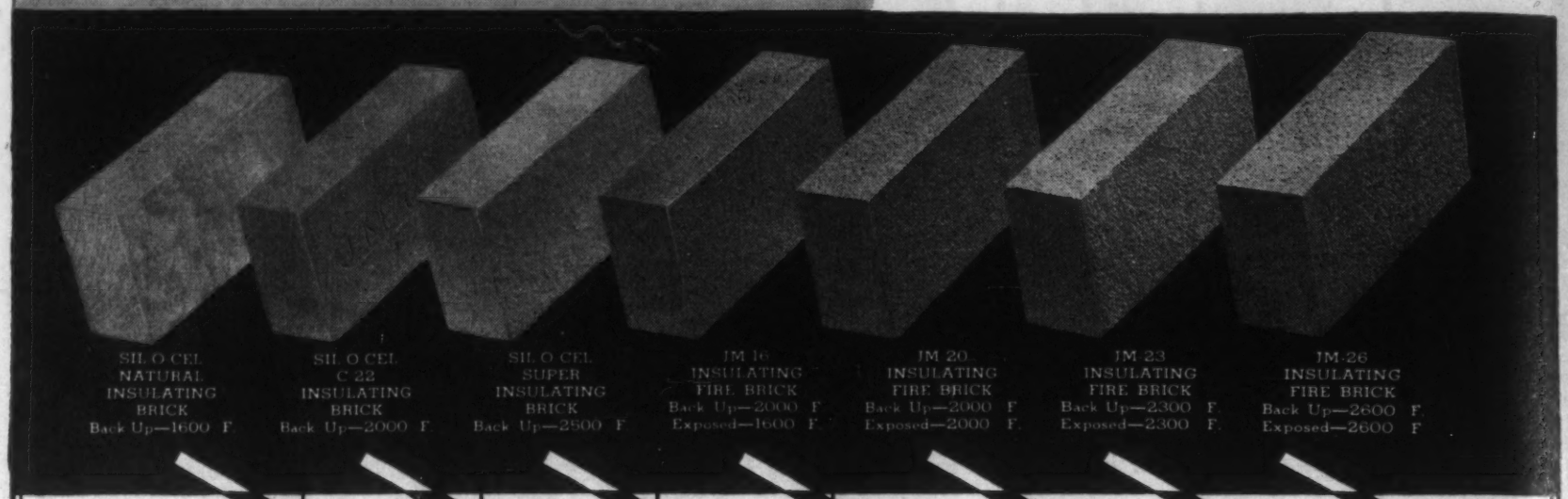

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Transverse Strength—lb. per sq. in.	140	115	90	70	100	135	150
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Linear Shrinkage—%	1.4 @ 1600° F	0.8 @ 2000° F	2.0 @ 2500° F	0.0 @ 2000° F	0.0 @ 2000° F	0.0 @ 2300° F	0.5 @ 2600° F
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Conductivity at Mean Temperature 500° F	1.01 .67	1.67	1.70	.75	1.01	1.26	1.61
1000° F	1.13 .79	1.88	1.95	1.01	1.19	1.49	1.90
1500° F	1.24 .90	2.08	2.19	1.41	1.49	2.05	2.61
2000° F	... ..	...	2.45	...	1.91	3.37	4.29
Recommended Service Back Up	1600° F	2000° F	2500° F	2000° F	2000° F	2300° F	2600° F
Exposed	....	....	....	1600° F	2000° F	2300° F	2600° F
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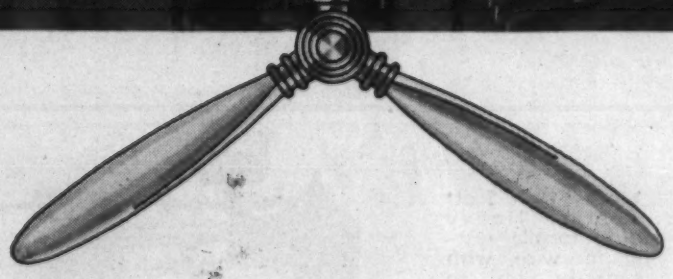

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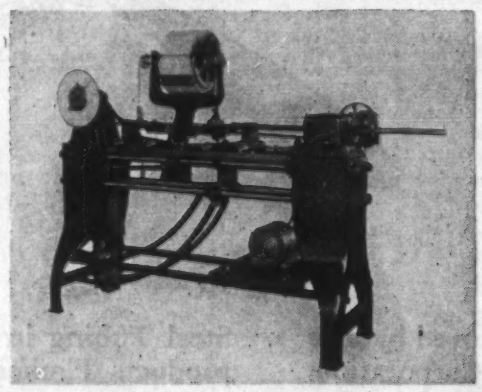

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★ Either paired with the correct WILCO Thermometal, or used alone, WILCO Aeralloy Aircraft Magneto Contacts are doing their part to assure *smooth* airplane performance. Other WILCO Electrical Contacts are giving equally dependable service in tank, ship and gun applications.

★ WILCO Thermometals, either separately or in conjunction with WILCO Electrical Contacts, are being used with the same success for aircraft oil temperature control and in various instruments for the Army and Navy.

BOTH AVAILABLE FROM ONE SOURCE

★ The facilities of THE H. A. WILSON COMPANY permit manufacturing customers to secure both electrical contacts and thermostatic bimetal from a single source. This is important because materials from these two groups are frequently used in conjunction, as parts in the same device. The most effective use of one necessitates a knowledge of the other. WILCO sales and engineering representatives are familiar with both Electrical Contact and THERMOMETAL application. Send us your problem for analysis.

WILCO PRODUCTS ARE: *Contacts* — Silver, Platinum, Alloys, Powder Metal. *Thermostatic Metal* — High and Low Temperature with Electrical Resistance from 24 to 530 ohms per sq. mil,-ft. *Precious Metal Collector Rings* for rotating controls. *Jacketed Wire* — Silver on Steel, Copper, Invar, or other combinations requested.

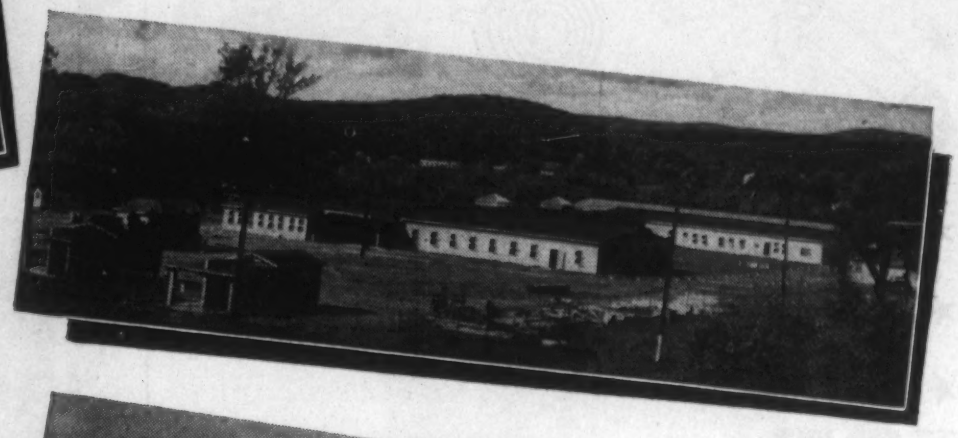
THE H. A. WILSON COMPANY

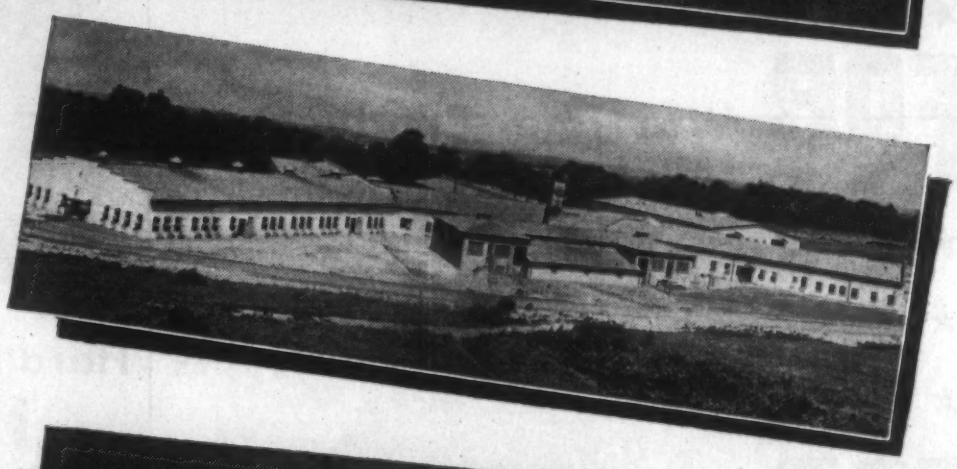
105 Chestnut St., Newark, N. J.

Branches: Chicago ★ Detroit

WILCO

Your Answer...Here?



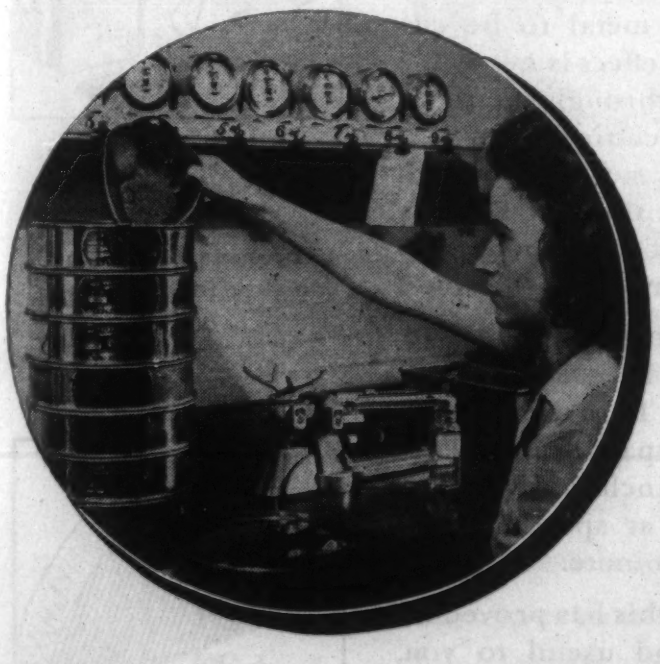


These 3 Modern Plants **are the largest facilities exclusively devoted to the disintegration of refractory metals and other materials.**

With the Finest Equipment **these facilities are busy today reducing magnesium to powder form for use in parachute flares, illuminating signals and tracer ammunition.**

Operated by highly skilled craftsmen Magna is turning out vast quantities of this vitally needed magnesium powder.

Under Rigid Control **...all production is tested and checked to maintain uniform high quality standards.**



And Tomorrow **will find Magna prepared to deliver finest quality metal powders in whatever quantities are needed to assure low cost quality fabrication. Management executives, sales, and design engineers are invited to consult with Magna *now*.**

MAGNA

MANUFACTURING COMPANY, INC.

MANUFACTURERS OF MAGNAFLAKE METAL POWDERS

444 MADISON AVENUE, NEW YORK 22, N. Y.

★ Actuating Elements

FOR TEMPERATURE RESPONSIVE DEVICES

Engineered from thermostatic bimetals, in shapes and of a type to meet your specific needs. Chace utilizes 25 different alloys to produce 35 different types of thermostatic bimetals.

FOR Wartime Products

Chace Thermostatic Bimetals are regularly used in vital control instruments for aircraft, tanks, trucks, cars, jeeps and numerous other implements of war requiring temperature responsive device.

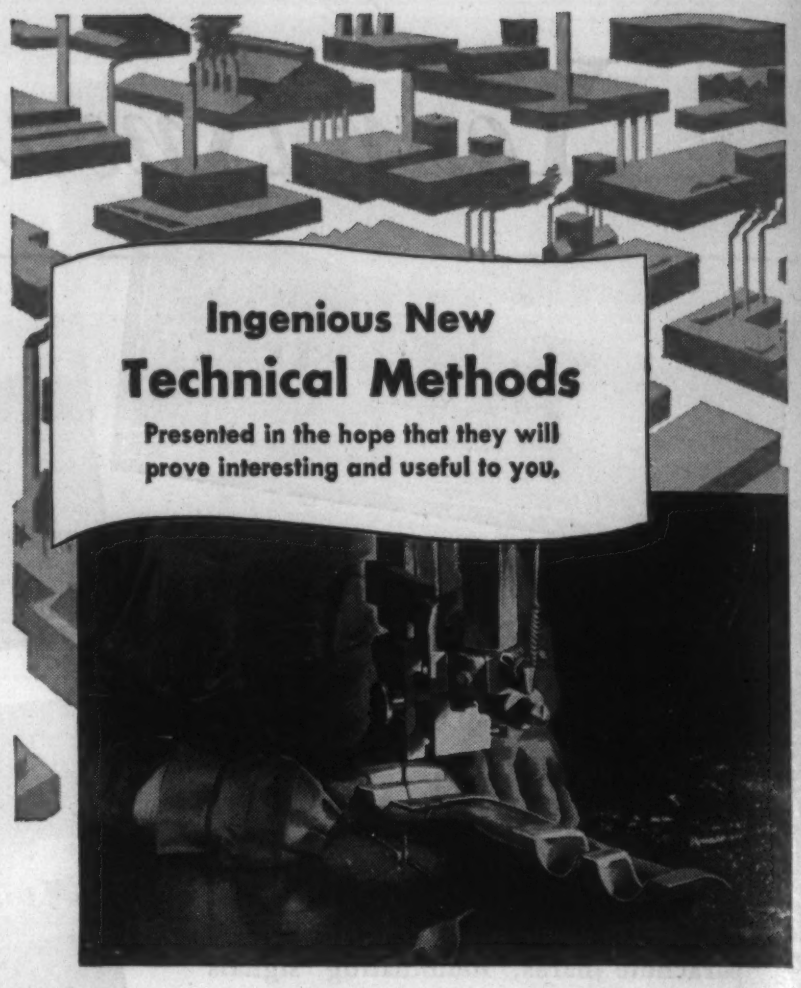
FOR Civilian and Post-War

To you manufacturers who will soon be producing the essential civilian products that require automatic temperature controls, and to you who are now planning post-war products that call for thermostatic actuating elements. . . . Two new types of thermostatic bimetals and three important manganese base alloys have been developed by and added to the W. M. Chace Company line of products.

●

Chace Thermostatic Bimetals are sold in shapes ready for assembly, also completed assemblies with terminals attached. Data sheets and engineering assistance cheerfully furnished on request.

W.M. CHACE CO.
Manufacturers of
Thermostatic Bimetals and Special Alloys
1615 BEARD AVE • DETROIT 9, MICH.



Ingenious New
Technical Methods
Presented in the hope that they will prove interesting and useful to you.

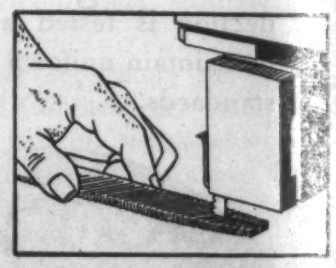
Hard Steels Cut by Heat Generated by Super High Saw Speeds

Ordinary band-saws, when operated at unbelievable high speeds up to 12,000 feet per minute, cut through hard steels and alloys by heat generated from the friction of the saw against the metal to be cut. The cutting effect is more that of burning through the metal than actual cutting. The heat generated is sufficient to melt or burn out the metal in the saw cut but not enough to draw the temper on the sides.

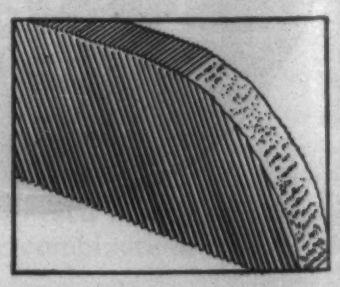
The hardness of either saw or metal to be cut is of little importance. Thin metal sheets are cut like paper, and plates up to one inch in thickness can be cut at speeds of ten inches per minute.

We hope this has proved interesting and useful to you, just as Wrigley's Spearmint Gum is proving useful to millions of people working everywhere for Victory.

You can get complete information about this method from Bell Aircraft Corporation, Buffalo, New York.



Proof of ability of new method to cut hard materials is demonstrated by operator cutting a file.



The temper of curve cut section shown above is unaffected.

X-61

Creative steel-making at Midvale is a partnership of imagination and science. Together they have perfected the most valuable alloys known to the industry. Together they look forward to challenges of the future. Whenever the question arises: "Can this be made of steel successfully?" Midvale welcomes the opportunity to look at the blue prints.

"E" with four stars

MIDVALE

Custom Steel-Makers to Industry

***PHILADELPHIA** • New York • Chicago • Pittsburgh • Washington • Cleveland • San Francisco*

WITH THE NEW *Eberbach* HARDNESS TESTER...

...YOU CAN DETERMINE THE HARDNESS OF:

SINGLE GRAINS IN ALLOYS · PLATING · NITRIDED AND CYANIDED LAYERS AND *PIECES TOO SMALL FOR OTHER TESTERS!*

The most valuable feature of the new Eberbach Hardness Tester is that with it, you can accurately gauge the hardness of single grains in alloys, plating, nitrided and cyanided layers and minute particles. Its ability to measure hardness of micro constituents directly in fundamental units, has won wide acceptance for this highly precise laboratory tool.

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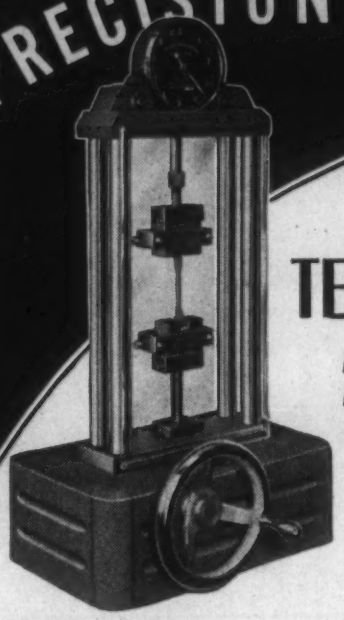
Write for the Eberbach Micro Hardness Tester brochure today. In it you will find the complete story of this amazing tester together with actual photomicrographs showing the results of difficult tests completed with ease on an Eberbach.

Eberbach & Son Company
ANN ARBOR, MICH.
LABORATORY APPARATUS & SUPPLIES
ESTABLISHED 1843

PRECISION TESTING



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TENSILE TESTER

FOR LABORATORY, PRODUCTION LINE OR FIELD TESTING

A HIGHLY PORTABLE UNIT IN A LOW PRICE RANGE

CAPACITIES UP TO 10,000 LBS.

Tests spot welded specimens, aluminum, steel, magnesium, plastics, wire, etc. Quick action jaws – easy to operate. Readily adaptable to compression or transverse testing. Fully portable, light weight, easily motorized. *Seven* capacities ranging from 250 lbs. up to 10,000 lbs. Finest workmanship – handsomely finished. In use by leading concerns everywhere. Extremely accurate, low in cost, good delivery.

WRITE TO DEPT. BM

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WANTED

General Manager With Metals and Wire Products Sales Management Experience

Excellent opportunity for a mature, broadvisioned sales executive with a metallurgical background and an outstanding sales management experience with fine wire and wire products.

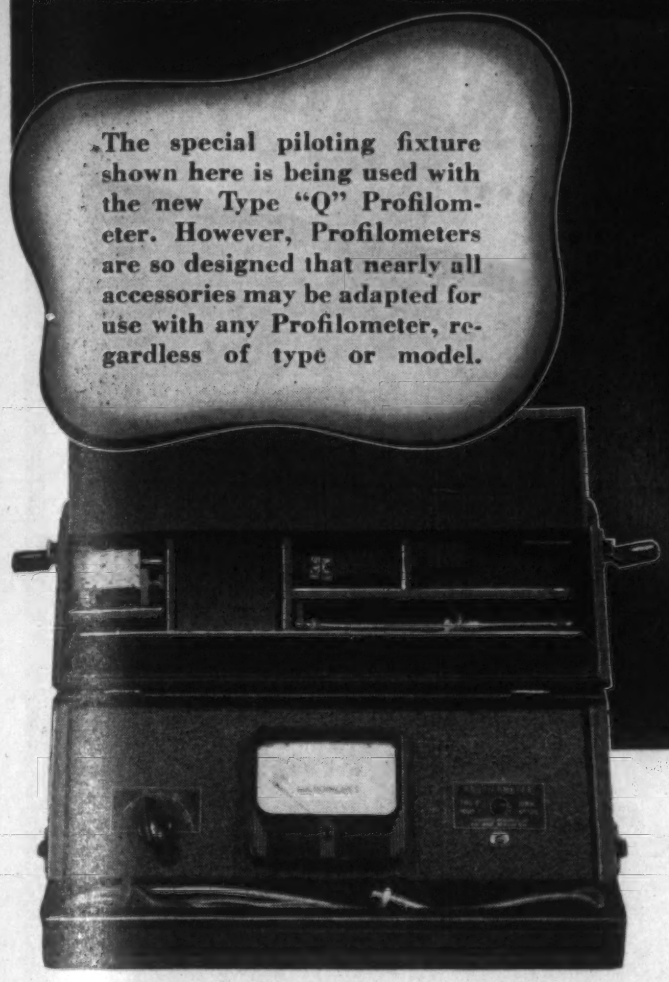
He must know the sales problems of this field intimately and be well acquainted with present and prospective purchasers of such products. He should be able to contribute constructive ideas on expanded sales to postwar markets.

This man will head one of our important sales divisions. Permanent position having definite postwar possibilities with organization of world-wide reputation in electrical research and development. Must be American citizen, preferably 35 to 42 years of age.

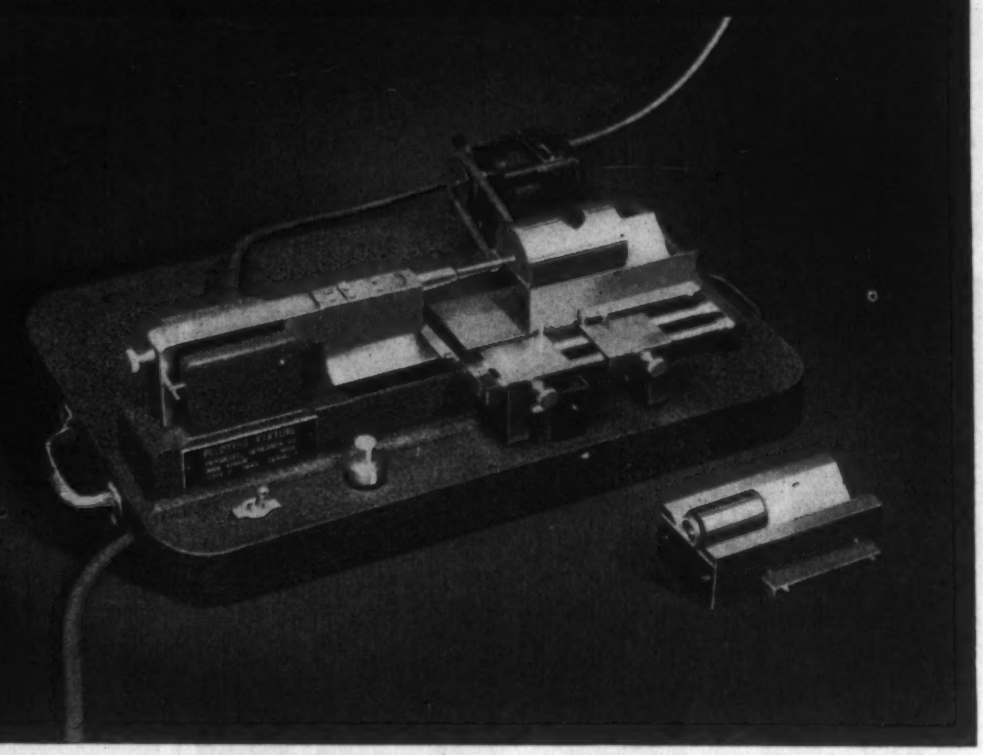
In replying, state age, education, draft status, full details of experience, salary requirements. Enclose photograph. Address O. M. E. Loupart, Executive Vice President, North American Philips Company, Inc., Dobbs Ferry, Westchester County, N. Y.

NORTH AMERICAN PHILIPS COMPANY, INC.

Specially Designed
PROFILOMETER* TRACERS and FIXTURES



The special piloting fixture shown here is being used with the new Type "Q" Profilometer. However, Profilometers are so designed that nearly all accessories may be adapted for use with any Profilometer, regardless of type or model.



TO MEET *Unusual* REQUIREMENTS IN *Measurement of Surface Roughness*

It has been found that the surface finish on the interior of small calibre shell dies has a definite effect on their useful life. Because of the tremendous pressures exerted on the surface of the die, small irregularities soon become enlarged and the die fractures.

Some time ago Physicists Research Company was given the problem of measuring the roughness of these smooth internal surfaces. After considerable experimentation the fixture shown above was developed. In this case a special tracer with an extra long, thin snout was required. On certain dies the snout was made to penetrate a ½" hole to a depth of 2½".

Manual operation of the tracer was unsatisfactory because of the unusual smoothness and small diameters involved. This fixture makes it possible for an unskilled man to obtain the correct roughness reading since he needs only to place the die in the fixture, push the starting button and observe readings directly on the Profilometer dial.

Through the use of such special fixtures and tracers the Profilometer can be adapted to measure the roughness of almost any surface regardless of its size, shape or position. If you have a problem in the measurement of any type of surface we will be pleased to work with you on it.

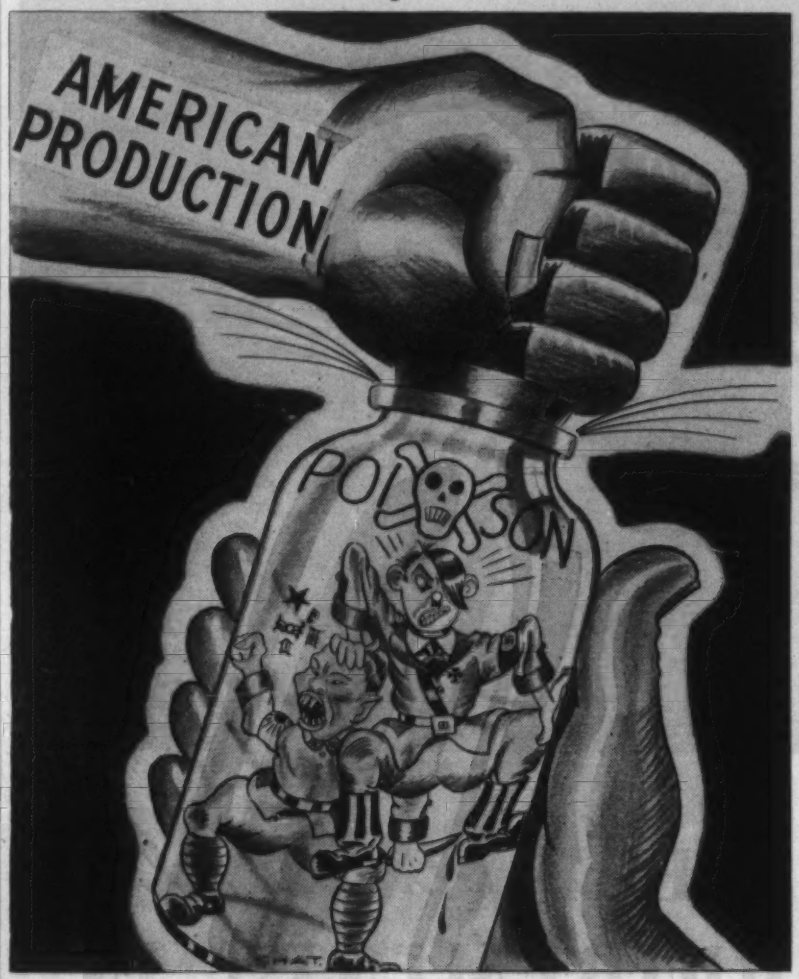
* *Profilometer is the trade name registered in the U. S. Patent Office by Physicists Research Company*

PHYSICISTS RESEARCH COMPANY

Manufacturers of Electronic Production Gaging Instruments

343 SOUTH MAIN STREET ANN ARBOR, MICHIGAN

"BOTTLED-UP"
by AMERICAN PRODUCTION



Good Old American Production! What a superb feat it has accomplished in "bottling up" hitler and tojo.

Our plants are indeed proud to be serving the Allies by doing "America's best plating job."

OUR NEAREST PLANT
STANDS READY TO SERVE YOU

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SCIENTIFICALLY BLENDED
FLUXES

Widely Used for Treating:

- ALUMINUM ALLOYS
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A. B. C. Foundrates:

- PROTECT
- REFINE
- PURIFY
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Also Recommended for
Recovering Good Metal from

- SKIMMINGS
- TURNINGS
- DROSSES

Our metallurgists will give technical advice on the use of A.B.C. Foundrates in your plant. Submit your problem, or write for further information. Address: Dept. F.

American-British Chemical Supplies, Inc.
180 Madison Avenue, New York
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. . . and drive even harder on the pay-roll savings plan!"

Make War Bonds the Christmas Order of the Day. Urge your workers to make their personal Christmas gifts in the form of War Bonds—and practice what you preach! Make this a 100% War Bond Christmas—to insure future Yuletides of peace and prosperity.

Make up your own posters to spread the "War Bonds for Christmas" story across your plant. Tell the story again and again on bulletin boards, in your plant magazine, and on pay envelope stuffers.

But don't forget your basic, all-important Pay-Roll Savings Plan. How's it going, these days? Perhaps it needs a bit of stoking-up right this very minute, to hold its full head of steam against the competitive demands of the holiday season.

Well, you're the man to stoke it! You can't expect it to keep running indefinitely on last summer's enthusiasm. See to it that your participation percentages, and your deduction percentages, *both* end up the year at new levels.

Every month, now your Pay-Roll Savings ought to run well ahead of the preceding month. *For so many families that formerly depended on the earnings of a single worker, now enjoy the combined earnings of several.* Such *family* incomes are doubled, trebled, even multiplied many times.

Now's the time to turn as much as possible of these increased earnings into War Bonds—War Bonds for Christmas . . . and War Bonds the whole year 'round!

GIVE THE PRESENT WITH A FUTURE—WAR BONDS!

This space contributed to Victory by **METALS and ALLOYS**

This advertisement prepared under the auspices of the United States Treasury Department and the War Advertising Council

"IT HAD TO COME"--

To use the words of an eminent metallurgical engineer, referring to the Weaver Furnace Atmosphere Indicator.

THE WEAVER FURNACE ATMOSPHERE INDICATOR is entirely automatic and continuous in operation, simple to understand, quick and accurate in response, rugged in construction, low in first cost and upkeep.

* IT improves results from the Heat Treatment of Metals and Alloys via Control and Regulation of Furnace Atmospheres.

* IT gives Fuel Economy — By eliminating guesswork in determining proper air-fuel ratios, fuel savings are made, which over a short period, more than earn the cost of the instrument.

* IT eliminates spoilage due to unknown causes.

Exclusively distributed by —

CLAUD S. GORDON CO.

Established 1914

Engineering Equipment and Service

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3000 South Wallace Street
Telephone—Victory 6525

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1988 E. 66th Street
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INDIANAPOLIS
Suite 211, 31 E. Georgia Street
Telephone—Market 6220

HELP WANTED MALE

Industrial Engineer with Rolling Mill experience, for Rolling Mill process and development work, preferably young and not subject to immediate induction. Forward brief summary of education and job experience with small photograph to Box 130.

METALS and ALLOYS

330 W. 42nd St., New York 18, N. Y.

CHEMICALS BY GLYCO

INGREDIENTS FOR MAKING LUBRICATING COMPOUNDS FOR DRAWING STEEL, ALUMINUM, ETC.

☆

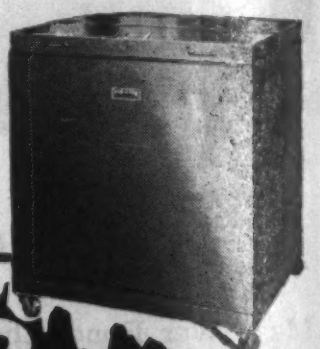
For complete information, send for our new catalogue, "Chemicals by Glyco."

GLYCO PRODUCTS COMPANY, Inc.

26 Court Street Brooklyn 2, New York

SUB ZERO CHESTS

Dependable quality insured -50° F to -75° F temperatures for aircraft and instrument testing.



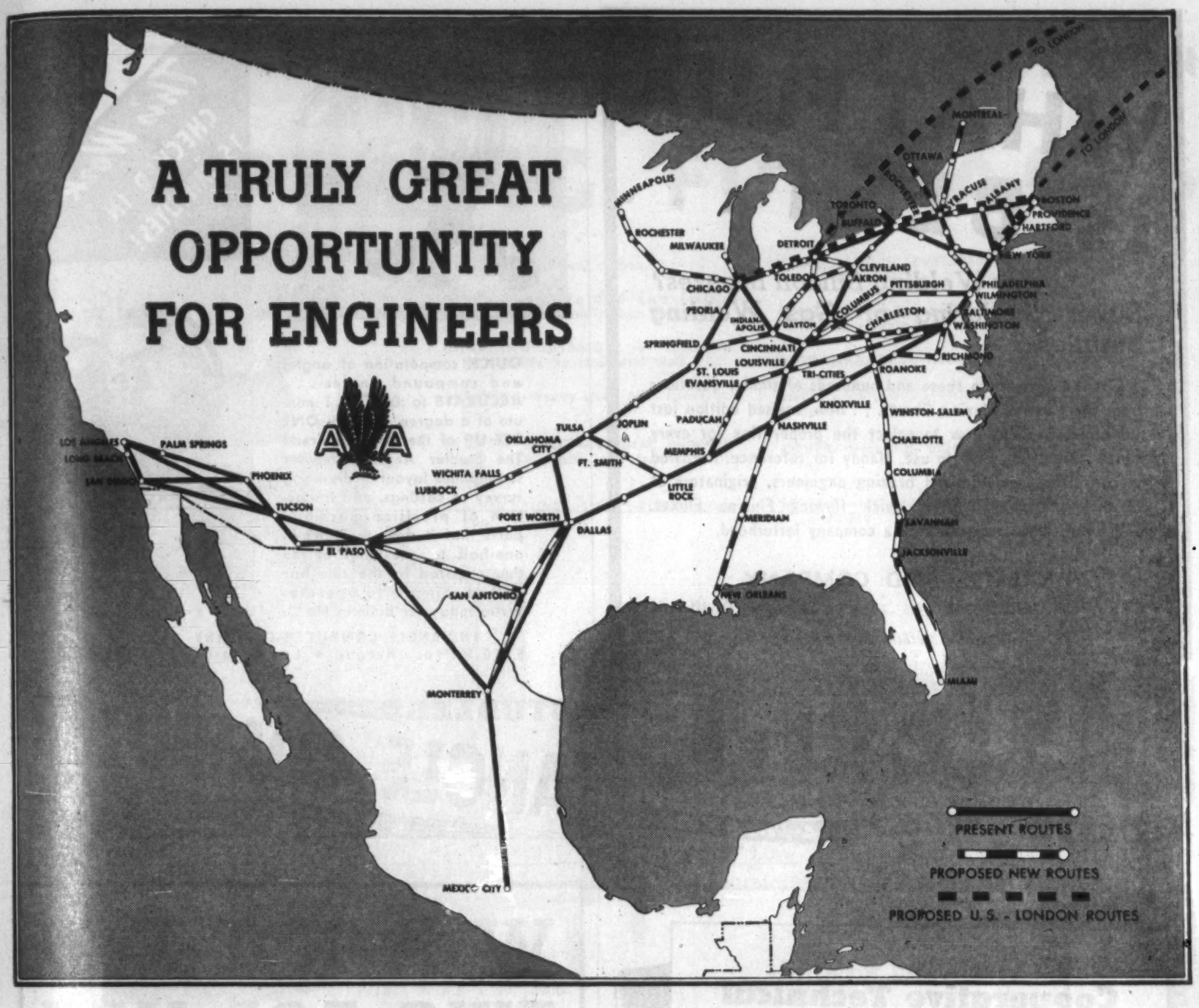
Revco INDUSTRIAL REFRIGERATION

RIVET DISPENSERS

An automatic method of selecting and dispensing refrigerated rivets in sealed cartridges at -30° F.

Write or wire for details.
Literature on request.

REVCO, INC., Deerfield, Michigan



THE map shown above is more than a map. It is a picture of one of the greatest opportunities ever offered to engineers. For it is the American Airlines system map, showing the present and the proposed new Routes of the Flagships.

The organization that operates passenger, mail and cargo airplanes over the current vast routes is seeking men for positions in its Engineering Department at La Guardia Field in New York. Men sparked by vision and ambition will be quick to see that here is not only the chance to take an active hand in vital war work, but get a head start toward a limitless peacetime future as well.

Air transportation is one business that surely is going to expand after the war. Here is your opportunity to help, and to grow with American Airlines.

Aeronautical experience is not required. If you have had at least two years of experience in the design or servicing of tools, machines or mechanical devices in mechanical, electrical or aeronautical fields, you can qualify. Candidates accepted will be given a full course in aircraft familiarization. Length of course and starting salary will depend on your experience.

Today, write the Personnel Department of American Airlines, Inc., at the address below, giving your past experience and detailed personal information, including draft status.

AMERICAN AIRLINES Inc.

PERSONNEL DEPARTMENT, SECTION "C," 100 EAST 42nd ST., NEW YORK 17, N.Y.

WHAT FLUX is BEST . . .

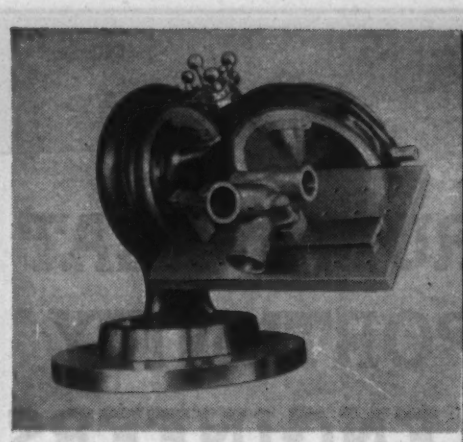
for Welding Silicon Bronzes?
Silver Soldering or Gas Welding Stainless?

Get the answers to these and hundreds of similar questions from the Krembs Fluxine Chart . . . new, revised edition just published. Explains how to select the proper flux for every metal-joining job. Easy to use. Handy for reference. Prepared by consulting, welding and brazing engineers, originators of 89 different non-bubbling, quick flowing Fluxine Fluxes. Chart free when requested on a company letterhead.

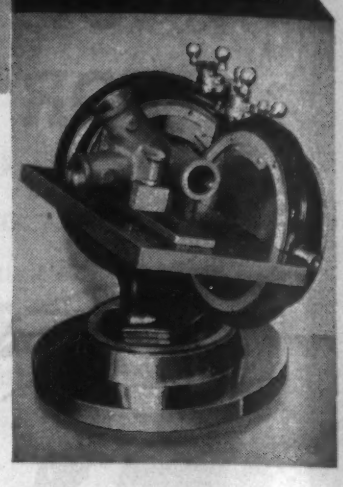
KREMBS AND COMPANY
677 West Ohio Street Chicago 10, Illinois

Chemists and Metallurgists Since 1875

FLUXINE
TRADE MARK REGISTERED U.S. PAT. OFF.
FLUXES TO JOIN ALL METALS



This Work CHECKED IN 15 MINUTES!



QUICK computation of angles and compound angles . . . **ACCURATE** to .001" or 1 minute of a degree . . . only **ONE SET-UP** of the work required! The Studler Angle Computer so simplifies layout of die work, survey of castings, and inspection of precision-machined parts that it does the work in one-half to one-tenth of the time required by the sine bar method. Simple to operate. Write today for Bulletin No. 2.

THE ANGLE COMPUTER COMPANY Dept. MA
5720 Melrose Avenue • Los Angeles 38, California

STUDLER ANGLE COMPUTER

Cooperative Technical Service on Your Cleaning Problems

Puzzling cleaning problems come up all too frequently in these days of fast production.

A quick solution is imperative.

It must be correct—mistakes don't go!

Our experienced men of technical skill and ability will soon find your difficulty, and remedy the fault in the cleaning, stripping or pickling operation.

They will demonstrate compounds developed for your particular requirements and help you find the fast efficient economical way to prepare your product for finishing.

PERMAG Cleaning Compounds

No obligation for an interview. Write or 'phone us.

MAGNUSON PRODUCTS CORPORATION

Mfrs. specialized scientific cleaning compounds for industry.

Main Office: 50 Court St. Brooklyn, N. Y.
Nationally Represented. Warehouses in chief cities
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WANTED TWO TOP MEN

A converted Magnesium Foundry (200,000 to 250,000 pounds per month) located in Ohio has immediate openings for two top men at good salaries.

1. Foundry Superintendent, fully experienced in magnesium or aluminum.

2. A thoroughly experienced Chief Metallurgist capable of directing all technical controls including chemical, metallurgical, melting, and both core and foundry sand.

There are openings on our present staff for two additional Metallurgists with plant experience.

In reply give complete record of experience, education and attach snap shot if available.

Box 120

METALS and ALLOYS
330 West 42nd Street New York, 18, New York

TRENT
TRADE MARK

ELECTRIC AIR CONVECTION
TEMPERING FURNACES

Air Draw Furnace With 22" in dia. x 36" deep basket. Unit plug partially exposed.

TYPES—Cylindrical or box.

UNIT—Trent Folded and Formed nickel chromium ribbon unit.

CHARGING CHAMBER — Separated from units by insulated wall.

BLOWER—Heavy duty alloy construction.

BLOWER SHAFT—Vertical, eliminating bent shafts and bearing failures.

TEMPERATURE—300-1400 degrees Fah.

TEMPERATURE EVENNESS—4 degrees from control point.

UNIT PLUG—Removable to facilitate inspection or cleaning.

MOVING PARTS—None inside furnace to wear.

SAFETY FEATURES—Air vane relay to protect units.

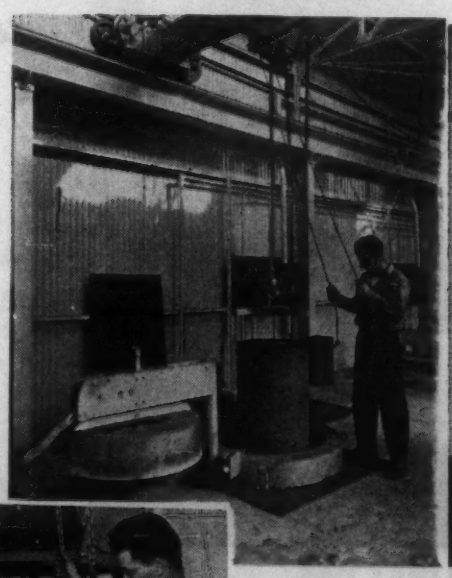
COVER—Floating, quick acting, positive seating.

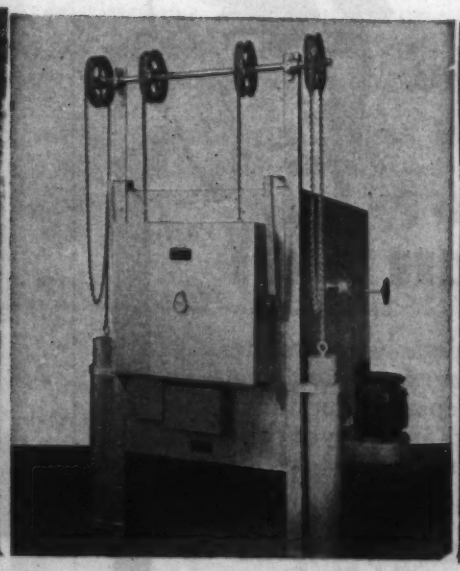
MOTOR—Mounted at top of furnace for accessibility.

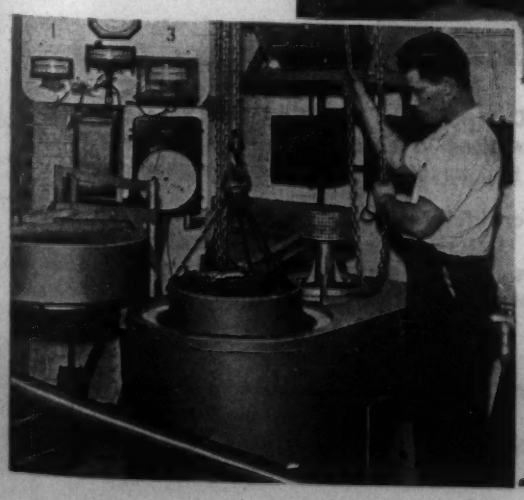
Twenty-three years' experience in the manufacture of electrically heated equipment, assures you the best in design and performance.

A Trent engineer will be glad to give you information in reference to Trent: Box, Pit, Air Draw, Conveyor, Salt and Lead Bath, or Laboratory Furnaces; Ovens, Kettles, High and Low Temperature Heating Elements, Laboratory and Calibrating Equipment.

Write for Bulletin 40 T.B.



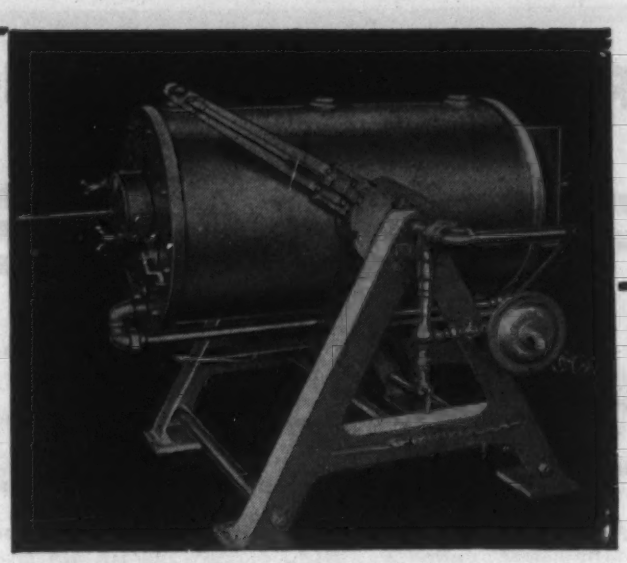




HAROLD E. TRENT COMPANY

4571 Wilde Street, Philadelphia 27, Pa.

MANUFACTURERS OF ELECTRICALLY HEATED INDUSTRIAL EQUIPMENT



SIMULTANEOUSLY
Tempering and Blackening

Combining two operations, i.e., temper drawing and giving the work a pleasing black finish, without first washing, means time and money saving. This method is very successfully employed in these machines on cap screws, set screws and numerous other small parts.

Write for four-page bulletin No. MA805 giving the complete story.

American Gas Furnace Co.
Elizabeth, New Jersey

How Oakite Degreasing Speeds Production for Wartime Executives

. . . EXTENDING LIFE OF YOUR ANODIZING RACKS

By using the NEW technique with Oakite Compound No. 84 for removing anodizing film from your hard-to-replace aluminum anodizing racks, straps and hooks, you obtain TWO significant advantages.

First, all film is removed so that full electrical conductivity is QUICKLY, EASILY restored. Second, film is removed without injuring the basis metal. This SAFE method is excellent for reclaiming rejects, too. Send for NEW, FREE 12-page booklet giving full details!

OAKITE PRODUCTS, INC., 32H Thames St., New York 6, N. Y.

Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada

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Darwin
WICKSITE
Tungsten Carbides

Wicksite Red No. 1: A general steel cutting grade, very strong wear, crater resistance material, recommended on all kinds of steel for general heavy, medium fast cutting. Also suitable for intermittent cuts.

Wicksite Red No. 2: A steel cutting grade, strong wear and crater resistance material, recommended on all kinds of steel for general, medium, light fast cutting.

Wicksite Green: A general purpose grade recommended for cutting cast iron, non-ferrous metals and non-metallic material.

Wicksite Purple: Outstanding universal grade for cutting all kinds of materials, non-ferrous and non-metallic. This carbide is especially recommended for rough cutting of steel and plowing cast iron, suitable for intermittent cuts, heavy duty.

All standard sizes of carbides described above are available for immediate delivery. Non-standard sizes and special tools manufactured to specifications promptly.

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highest grade tool steels
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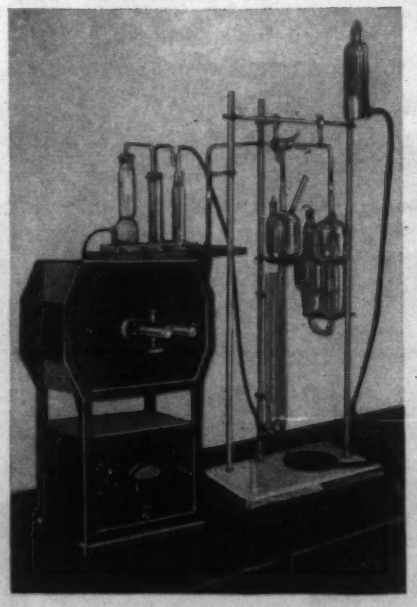

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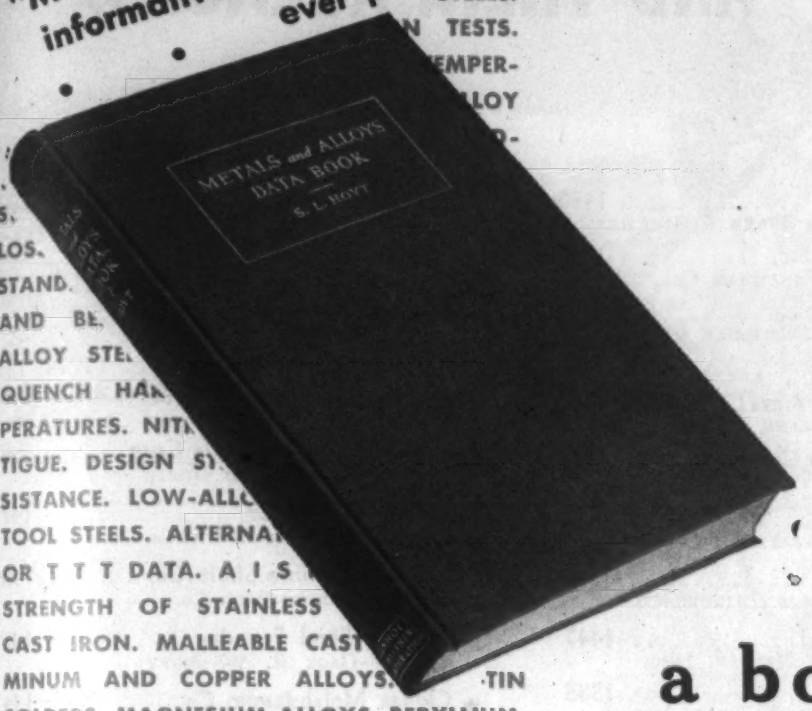

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At present, we are busy filling the refractories requirements of war industries. Without interrupting our efforts in this direction, however, we find time to discuss plans for the future because we know that tomorrow's problems must be solved today. They cannot be put off until tomorrow for tomorrow would be too late.

Being fully cognizant of this fact many laboratories—many pilot plants—are already working on new and improved materials and equipment for the post-war period. In some of this work refractory problems will undoubtedly arise in the solution of which we would like to lend a hand.

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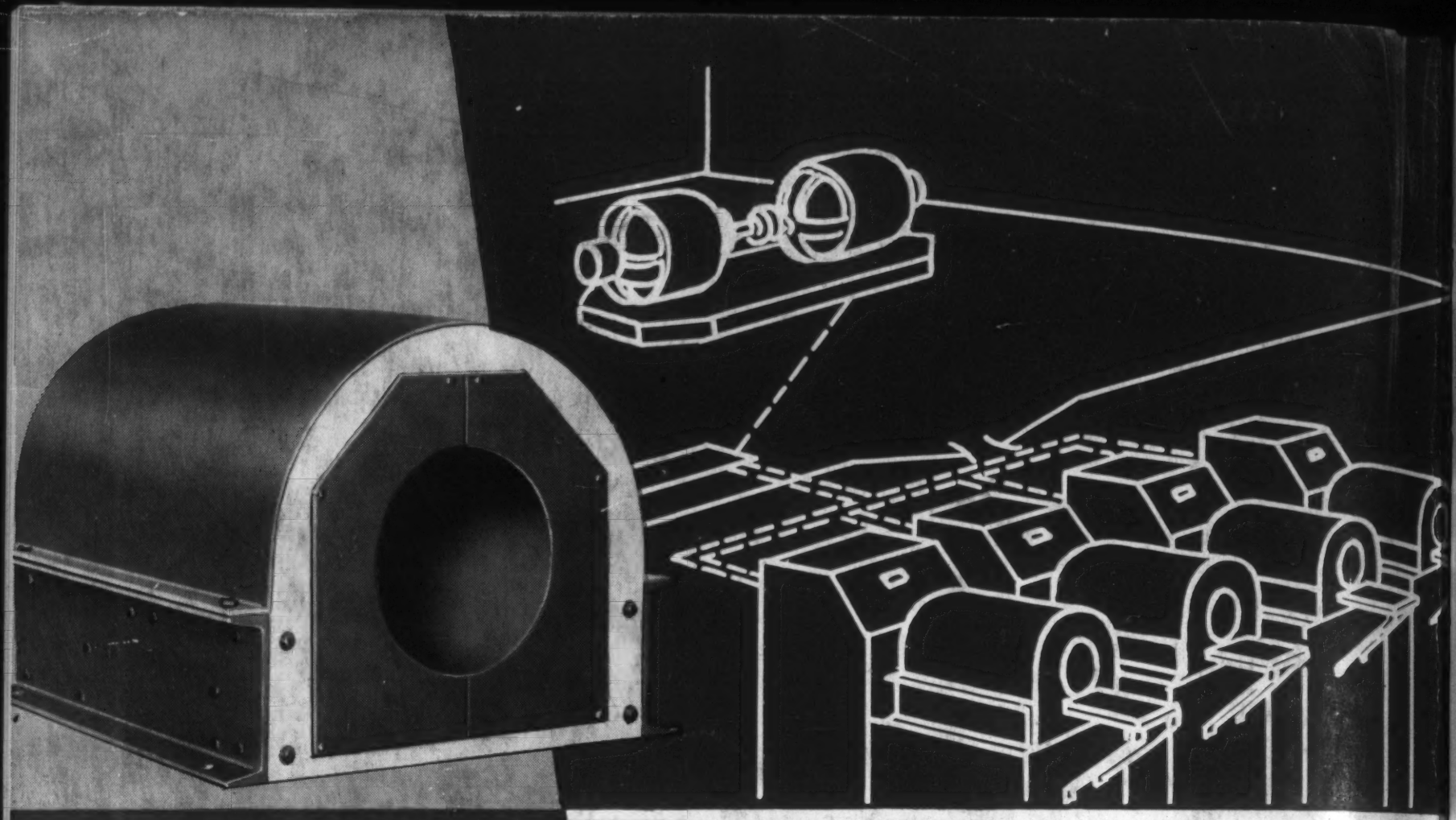

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